United States
Department of
Agriculture

Forest Service

Southeastern Forest
Experiment Station

General Technical Report SE-31

User's Manual for Total-Tree Multiproduct Cruise Program

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February 1985

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ABSTRACT

The Total-Tree Multiproduct Cruise Program is a user-friendly, interactive computer program that uses standard tree-cruise data to estimate the weight and volume of the total tree, saw logs, plylogs, chipping logs, pulpwood, crown firewood, and logging residue in timber stands. Input is cumulative cruise data for tree counts by d.b.h. alone or by d.b.h. class and total height, height to 4-inch top, or saw-log merchantable height for individual species or species groups. Output is in tables: (1) board-foot volume by d.b.h., (2) total-tree and tree-component biomass by d.b.h. class, (3) a summary table, and (4) projected annual growth by stand component and species. Output can be expressed in tons, cords, cunits, or board feet per acre, or by cutting units and tract totals. The program is written in FORTRAN V for a mainframe and in PASCAL for the IBM-PC microcomputer. This manual describes the program and how to enter cruise data to obtain desired output for both the mainframe and microcomputer versions.

Keywords: Computer program, inventory, biomass, tree weight, tree volume.

Introduction

Timber utilization practices are rapidly changing. The southern pines are now tree-length logged and marketed for veneer, saw logs, and pulpwood by weight rather than measured by scale stick to determine board feet or cords. Poor-quality hardwoods are now harvested for total-tree fuel chips, and logging residue from sawtimber hardwoods is marketed for firewood. To stay abreast of the changing utilization practices, to save time, and to reduce cruise computation errors, foresters need a versatile, easy-to-use procedure for automatically estimating the weight and volume of the total tree and its components (saw logs, plylogs, chipping logs, pulpwood, firewood). The Total-Tree Multiproduct (TTMP) Cruise Program meets this need.

TTMP Cruise Program is a computer program designed for general forestry application. It accepts cumulative cruise data collected by standard timber cruise procedures. It provides per acre or per area estimates of total-tree and tree-component biomass and product yields for trees 1-inch d.b.h. and larger. Area estimates can be summarized by cutting units within a tract. The output estimates can be expressed in tons, cords, or cunits, and in board feet by using the Doyle, Scribner, or International 1/4-inch board-foot rules for saw-log volumes.

This manual is a guide to the user of the TTMP Cruise Program and will assist in the interpretation of biomass and product estimates it provides. The manual also explains the program's capabilities, how it is designed, and how it calculates forest biomass and product estimates.

The mainframe version is written in Fortran V and is designed to be accessed from remote terminals. The use of standard language syntax simplifies the conversion of this program for running on other systems supporting FORTRAN V. It is currently operational on a CDC CYBER 750 and an IBM 370. The microcomputer version is written in UCSD PASCAL for operation on IBM-PC and IBM compatible microcomputers that use the p-System (C2.A) operating systems developed by Network Consulting, Inc. (NCI).[1] It is a turnkey program and requires two disk drives

[1] Copyright C 1984, Network Consulting, Inc.; Copyright C 1984, Softech Microsystems, Inc.

and a minimum of 256K RAM storage. The program was developed by the Utilization of Southern Timber Research Work Unit, USDA Forest Service, Southeastern Forest Experiment Station, in cooperation with the Georgia Forestry Commission and the University of Georgia's School of Forest Resources. For information on obtaining either version, write to the Southeastern Forest Experiment Station, 200 Weaver Boulevard, Asheville, NC 28804.

The program is designed for use by foresters or clerical personnel with little or no previous computer experience. The program prompts the user to enter information describing the cruise and the necessary tree counts. Data entry in the microcomputer version is interactive, fast, menu-driven, and self-explanatory. Special features are included that minimize the number of user key strokes per run. Data can be quickly entered and edited. The interactive procedure of the mainframe is self-explanatory and easily correctable. The same input data is requried for both versions and the output is identical.

The first version of the TTMP Cruise Program, called Total Biomass Cruise Program (Clark and Field 1981), has been operational for 3 years. The program has been used by the Georgia Forestry Commission to analyze more than 300 cruises. Other States, industries, consultants, and the USDA Forest Service have used it experimentally and support its increased availability.

Program Design

The TTMP Cruise Program uses tree data commonly measured in standard cruise procedures to estimate not only conventional forest products but total-tree and residual biomass.

Tree Size Classes

Trees must be separated into three size classes for input, analysis, and output:

Saplings--trees 1.0 to 4.9 inches d.b.h.

Pulpwood--or roundwood trees $\geq$ 5.0 inches d.b.h.

Sawtimber--trees $\geq$ 9.0 inches d.b.h. for pine and trees $\geq$ 11.0 inches d.b.h. for hardwoods containing a minimum of one 16-foot number 3 saw log

The mainframe version requires that pulpwood trees be entered in two tree size classes:

Pulpwood--or roundwood trees 5.0 to 8.9 inches d.b.h. for pine and 5.0 to 10.9 inches d.b.h. for hardwoods

Large pulpwood--or roundwood trees $\geq$ 9.0 inches for pine and trees $\geq$ 11.0 inches for hardwoods

Tree Dimensions Measured

During a cruise, the user can choose among various combinations of tree d.b.h. and height for measurements. Trees can also be tallied by d.b.h. alone, but this will produce less-precise summaries. The following combinations of tree dimensions and their range by tree size class can be accepted by the program. D.b.h. can be tallied at intervals of 1 or 2 inches up to 30 inches:

Tree dimension combinations	Size class and tally interval
SAPLINGS	
d.b.h.	1.0 to 4.0 inches
d.b.h and tree total height	10 to 90 ft in height at 5- or 10-ft intervals
PULPWOOD AND LARGE PULPWOOD	
d.b.h.	$\geq$ 5.0 inches
d.b.h. and tree total height	10 to 140 ft in height at 10-ft intervals or 20 to 100 ft in height at 5-ft intervals
d.b.h. and height to a 4-in d.o.b. top	10 to 140 ft in height at 10-ft intervals or 5 to 85 ft in height at 5-ft intervals
SAWTIMBER	
d.b.h.	$\geq$ 9.0 inches for pine $\geq$ 11.0 inches for hardwoods
d.b.h. and tree total height	10 to 140 ft in height at 10-ft intervals or 30 to 110 ft in height at 5-ft intervals
d.b.h. and height to a 4-in d.o.b. top	10 to 140 ft in height at 10-ft intervals or 20 to 100 ft in height at 5-ft intervals
d.b.h. and saw-log merchantable height	1.0 to 6.0 (16.3 ft) logs in height at half-log intervals

The selected d.b.h. and heights measured should be based on the type of timber cruised and objective of the cruise. When cruising pines, d.b.h. in combination with total height or height to a 4-inch d.o.b. top will give good estimates of the total tree, stem to pulp top, and stem to a fixed saw-log top of 7 inches. D.b.h. and saw-log merchantable height will give good estimates of the stem to a saw-log variable top. When cruising hardwoods by hard hardwood and soft hardwood groups, d.b.h. and total heights or height to a 4-inch top will also give good estimates of the total tree, stem to 4-inch top. These measurement combinations, however, can result in less-accurate estimates of the merchantable saw-log stem since these measurement combinations estimate to a fixed top of 9 inches d.o.b. and not a variable saw-log top. To obtain the best estimate of the saw-log merchantable stem, hardwoods should be tallied by d.b.h. and saw-log merchantable height.

Types of Cruises

The program has the capability of analyzing cruise data collected according to the following specifications:

1. Fixed-area plot--for any specified circular plot size,
2. Point sample--by using a prism with any specified prism factor,
3. Strip cruise--given width and total length of strip or percent of tract cruised and tract acreage,
4. 100 percent tree tally.

All trees $\geq$ 1.0 inch d.b.h. can be tallied by the same cruise procedure, or saplings (1.0 to 4.9 inches d.b.h.) can be tallied by using a different cruise procedure than that used for trees $\geq$ 5.0 inches d.b.h.

Species Tallied

The program contains weight and volume equations for the 10 most important species or species groups for each of the three main physiographic regions of the South--Gulf and Atlantic Coastal Plains, Piedmont, and Southern Appalachian Mountains. Thus the user can select weight and volume prediction equations developed for a general geographic area to expand specific-area cruise data to forest stand biomass estimates. Equations are stored in the program for the following species or species group. Also shown are the location, number, and d.b.h. range of the trees sampled to develop the species weight and volume equations used in the program.

Species name	Species sampled	Locations sampled	Trees sampled	D.b.h. range
			(No.)	(Inch)
	COASTAL PLAIN REGION			
PINE	Natural loblolly, slash, longleaf combined	Alabama, Georgia, South Carolina	1285	1-24
HARD-HARDWOODS	Hard hardwood species--white oak, water oak, laurel oak, hickory spp. combined	Coastal Plain of South and Southeast	303	1-20
SOFT-HARDWOODS	Soft hardwood species--sweetgum, blackgum, red maple, water tupelo, green ash, yellow-poplar combined	Coastal Plain of South and Southeast	842	1-20
OAK SPECIES	White oak, water oak, laurel oak combined	Coastal Plain of South and Southeast	138	1-20
LIVE OAK	Live oak	Northwest Florida	28	5-20
SWEETGUM	Sweetgum	Coastal Plain of South and Southeast	313	1-20
PINE2	Same as PINE--allows user to tally pine in two classes, sawtimber or poles	Alabama, Georgia, South Carolina	1285	1-24
SAND PINE	Sand pine	Northwest Florida	36	4-14
PLANTATION PINE	Plantation slash pine	Georgia	139	2-12
CYPRESS	Pond cypress	Central Florida	58	5-18

Species name	Species sampled	Locations sampled	Trees sampled	D.b.h rang
			(No.)	(Inch)
	PIEDMONT REGION			
PINE	Natural loblolly and shortleaf combined	Alabama, Georgia, South Carolina	1006	1-20
HARD-HARDWOOD	Hard hardwood species--southern red, scarlet, white oaks, and hickory combined	Georgia, Tennessee, South and North Carolina	189	1-20
SOFT-HARDWOOD	Soft hardwood species--yellow-poplar, red maple, sweetgum, green ash, sycamore combined	Georgia, South and North Carolina	126	1-20
WHITE OAK	White oak	Georgia, South and North Carolina	63	1 -20
RED OAK	Southern red oak, scarlet oak combined	Georgia, Tennessee, South and North Carolina	98	1-22
SWEETGUM	Sweetgum	Georgia, South and North Carolina	61	1-20
PINE2	Same as PINE--allows user to tally pine in two classes, sawtimber or poles	Alabama, Georgia, South Carolina	1006	1-20
VIRGINIA PINE	Virginia pine	Georgia	25	6-14
PLANTATION PINE	Plantation lolbolly pine	Alabama, Georgia, South Carolina	434	2-12
YELLOW-POPLAR	Yellow-poplar	Georgia, South and North Carolina	65	1-20
	SOUTHERN APPALACHIAN MOUNTAIN REIGON			
PINE	Natural loblolly and shortleaf combined	Alabama, Georgia, South Carolina	1006	1-20
HARD-HARDWOOD	Hard hardwood species--Northern red, white, chestnut, black, and scarlet oaks, hickory, black locust, sweet birch combined	Georgia, North Carolina	269	1-24

Species name	Species sampled	Locations sampled	Trees sampled	D.b.h. range
			(No.)	(Inch)
SOFT-HARDWOOD	Soft hardwood species--yellow-poplar, red maple, basswood, blackgum combined	Georgia, North Carolina	113	1-24
WHITE OAK	White oak	North Carolina	28	5-22
RED OAK	Northern red oak	North Carolina	71	5-24
YELLOW-POPLAR	Yellow-poplar	North Carolina	65	5-28
WHITE PINE	White pine	Georgia	36	1-24
VIRGINIA PINE	Virginia pine	Georgia	25	1-14
RED MAPLE	Red maple	North Carolina	36	5-16
HICKORY	Hickory spp.	Georgia, North Carolina	54	5-22

A maximum of six species or species groups can be entered for each area or cutting unit and a total of nine different species groups can be summarized for a total tract. The PINE2 species group is included to allow foresters to tally pine timber in two classes--sawtimber for lumber and veneer, and pole-grade trees for utility poles and pilings or to tally cut-and-leave trees.

Component Weight and Volume Estimates

Total-tree and tree-component weight and volume equations for estimating the green weight of wood and bark in pounds, and volume of wood in cubic feet, are stored in the program by region, species, tree size class, dimension measured, and tree component. The equations used in the TTMP Cruise Program were developed from biomass data collected across the South by the Utilization of Southern Timber Research Work Unit (fig. 1) in cooperation with the forest industries, Region 8 of the USDA Forest Service, North Carolina State Hardwood Research Cooperative, Georgia Forestry Commission, and Tennessee Valley Authority. These equations are available upon request from the authors, Utilization of Southern Timber Research Work Unit, Forestry Sciences Laboratory, Carlton Street, Athens, GA 30602.

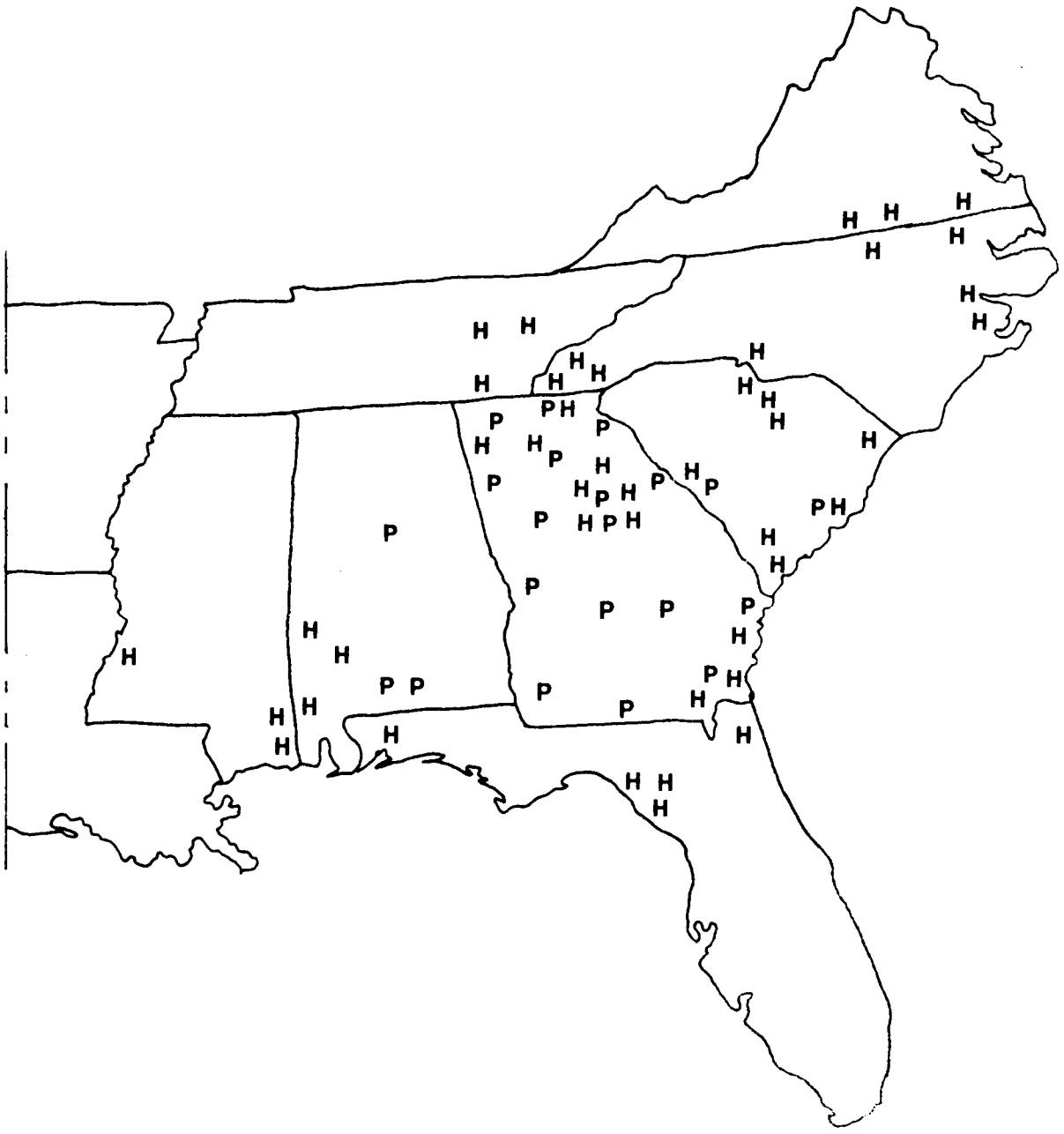


Figure 1.--Locations of stands where natural pine (P) and hardwood (H) trees were sampled for regional species equations.

The program prompts the user for the information needed to select the appropriate equations which are used with the tree-frequency counts to estimate total-tree and tree-component weights and volumes. Estimated weight in pounds and volume in cubic feet are converted to tons and cunits, respectively.

Total-tree and tree-component estimates in cords are calculated from the estimated weight of wood and bark to simulate one of the measurements used in selling wood. The following weight of wood and bark per cord equivalents are stored in the program:

Geographic region and species group	Cord equivalent (Pounds)
Coastal Plain	
Pine	5600
Hard hardwood	5700
Soft hardwood	5700
Piedmont	
Pine	5350
Hard hardwood	5700
Soft hardwood	5700
Appalachian Mountains	
Pine	5350
Hard hardwood	5800
Soft hardwood	5800

The pounds per cord equivalents are the same for hard hardwood and soft hardwood because soft and hard hardwoods are generally mixed when weighed at the woodyard. Users may enter their own factors for any of the species groups.

The user may specify the pulpwood d.o.b. top to be used for pine, hard hardwoods, and soft hardwoods in the analysis. This option allows the program to estimate more accurately the actual volumes to be harvested and what will be left as logging residue. The user may also request that the saw-log merchantable stem of natural southern pine be separated into small saw logs and into logs of suitable size for processing into veneer (plylogs). To do so, the user either specifies the minimum d.b.h. tree from which plylogs can be cut and the minimum top d.o.b. to which plylogs can be bucked or allows the program to use the default values of 13 inches d.b.h. and 10 inches d.o.b. top.

Upon request, the program will separate the stem of plantation pine into chipping logs and upper stem pulpwood. The user specifies a minimum d.o.b. top to which chipping logs can be cut and the minimum d.b.h. tree from which chipping logs can be processed or can use the default values of 8 inches d.b.h. and 6 inches d.o.b.

Board-foot volumes are estimated with equations developed from Mesavage and Girard (1956) volume tables (Appendix A). The user can specify the log rule (Doyle, Scribner, or International 1/4-inch) and form class to be used for estimating pine, hard hardwood, and soft hardwood board-foot volumes. No board-foot estimates are made unless d.b.h. and height (total height, height to 4-inch d.o.b. top, or saw-log merchantable height) are entered.

Growth Projection

The estimated weight and volume of a stand and its components can be projected for up to 5 years into the future. The user can input growth measurements or use growth values stored in the program. The growth measurements

entered by the user consist of the previous 5 years' radial growth (excluding bark) and tree d.b.h. The user can enter the measurements for trees in both the pulpwood and the sawtimber-size classes for pine. The stored growth values consist of equations with d.b.h. used as the independent variable for predicting the radial growth of a tree. These equations were developed for pine, other softwoods, hard hardwood, and soft hardwoods by the three physiographic regions from forest inventory data collected in the Southeast by the Forest Inventory and Analysis Research Work Unit (FIA), Southeastern Forest Experiment Station, Asheville, NC (Joe P. McClure, Project Leader; pers. commun., 1983). Since default radial growth values used in the program are regional averages, users should enter radial growth measurements for the trees cruised to obtain more accurate growth projections.

Growth projections are made by using the stand table projection method (Avery 1967:233-235). This method assumes that trees in each diameter class are evenly distributed throughout the class and that each tree will grow at the average rate for that class. It also assumes that bark thickness does not change during the 5-year period. In addition to projecting growth in d.b.h., height projections are also made by using equations developed by FIA (Joe P. McClure, Pers. commun., 1983). Height growth equations are stored in the program for pine, other softwoods, hard hardwoods, and soft hardwoods for each of the three physiographic regions.

Mortality is then automatically subtracted from the projections by applying factors, based on FIA data, to the tree counts by d.b.h. class:

Tree d.b.h. class (Inches)	Annual mortality rate (%) (Softwoods)	(Hardwoods)
≤ 6	1.9	1.1
$> 6 - < 22$	0.7	0.8
≥ 22	1.1	1.4

Projected tree and component weights and volumes are estimated by using the appropriate equations applied to the projected tree counts and d.b.h. and height values.

Data Input

Cruise data collected for a 40-acre pine-hardwood tract in the Coastal Plain will be used as an example in this manual. Trees 1.0 inch d.b.h. and larger were tallied in 2-inch classes with a 10-factor prism at 40 points in the tract. Default radial growth values were used to estimate growth. Exhibits 1 and 2 are examples of the completed field forms for recording cruise information and cumulative tree counts, by d.b.h. and height classes. Samples of blank forms are included at the end of the manual; however, conventional cruise tally cards can be used to record cruise data.

Exhibit 1. - - **TOTAL TREE MULTI-PRODUCT CRUISE PROGRAM--Summary Form for Recording Cruise Counts**

District No. 14 Case No. 16 A. Landowner John Doe Address Main St. Athens, Ga. 30605
Geographic Region 4 Acreage in Tract 40 No. Areas in Tract ____ Tract Location Green Co.
Forester Smith Address Athens, Ga. Phone 404-546-2441
Area No. 1 Area Acreage 40 Type Cruise Point No. Plots 40 Planted or Natural Natural
Area Identification Pine-Hardwood Species Pine Date 4/5/84

PLOT NO.	DBH	SAPLING COUNT	DBH	SAPLING COUNT
1	2	6	4	18

PULPWOOD--HEIGHT TO 4-INCH TOP (FEET)

DBH	10	20	30	40	50	60	70	80	90
6	4	11	12						
8		6	17	27	8				
12				2	1				
16					2				

SAWTIMBER--SAW-LOG MERCHANTABLE HEIGHT (LOGS)

DBH	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
10	5	20	20	1					
12	2	16	25	8					
14		16	12						
16		2	15	14					
18		1	2	3	1				
20		1	4	4	1				

Exhibit 2. - - **TOTAL TREE MULTI-PRODUCT CRUISE PROGRAM--Summary Form for Recording Cruise Counts**

District No. 14 Case No. 16A Landowner John Doe Address Main St. Athens, Ga. 30605
Geographic Region 4 Acreage in Tract 40 No. Areas in Tract ____ Tract Location Green Co.
Forester Smith Address Athens, Ga. Phone 404-546-2441
Area No. 1 Area Acreage 40 Type Cruise Point No. Plots 40 Planted or Natural Natural
Area Identification Pine - Hardwood Species Hard + Soft Hardwood Date 4/5/84

	Hard Hardwood									Soft Hardwood							
PLOT NO.	DBH	COUNT			DBH	COUNT				DBH	COUNT			DBH	COUNT		
	2	3			4	14				2	9			4	12		
		PULPWOOD--HEIGHT TO 4-INCH TOP (FEET)															
		10	20	30	40	50	60	70	80	10	20	30	40	50	60	70	80
1	6	2	4	2						1	5	2					
2	8		4	6	5						6	8	1				
3	10				1												
4	14					2											
5																	
6																	
7																	
8		SAWTIMBER--SAW-LOG MERCHANTABLE HEIGHT (LOGS)															
9		1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
10	12		5									8					
11	14		6	10								8	10	4			
12	16			4									4				
13	18			2													
14	20																
15	22																
16																	
17																	
18																	
19																	
20																	

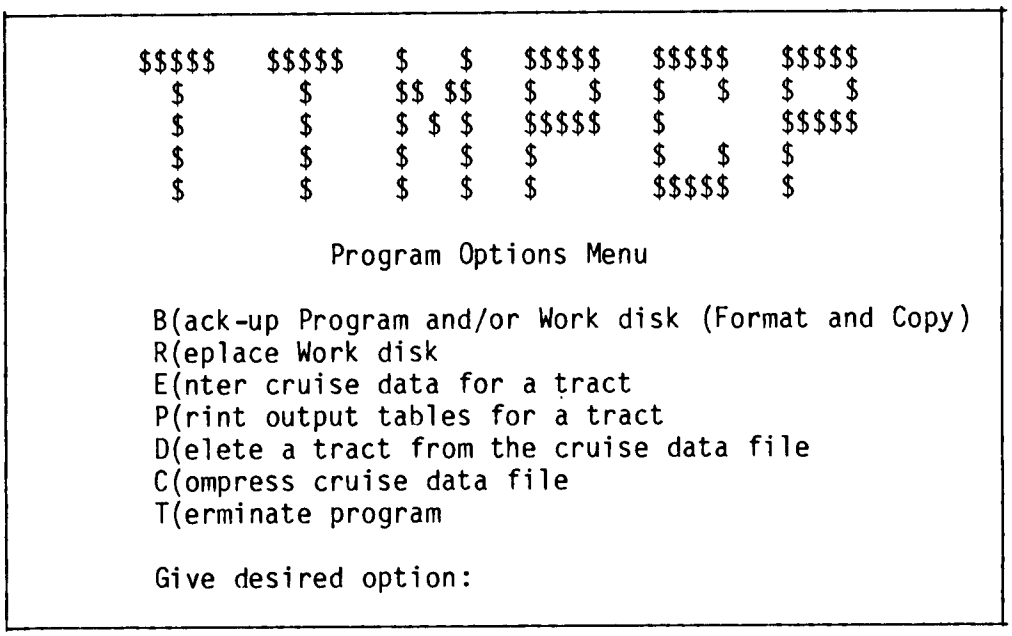
Microcomputer Example

The microcomputer version is distributed on two 5-1/4-inch double-sided, double-density floppy disks. The program disk contains NCI's p-System operating system and the compiled PASCAL code for the TTMP Cruise Program. The second disk is the work disk and contains the species weight and volume equation coefficients and is used to store cruise data output for printing.

To run the micro version, place program disk in drive A and the work disk in drive B and "boot-up" the computer. After the NCI copyright message, the introduction describing TTMPCP will appear on the screen as shown below:

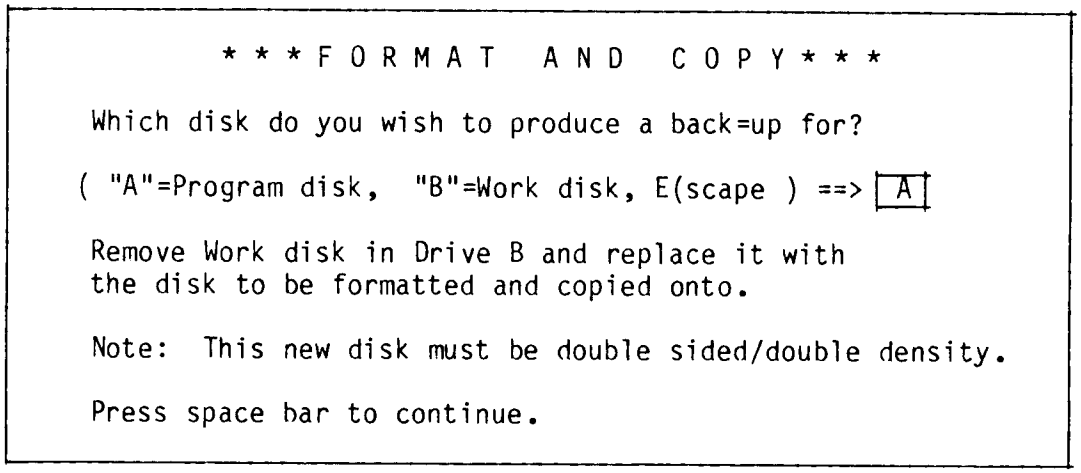
```
 $$$$$   $$$$$   $   $   $$$$$   $$$$$   $$$$$
   $       $     $$ $$   $   $   $   $   $   $
   $       $     $ $ $   $$$$$   $       $$$$$
   $       $     $   $   $       $   $   $
   $       $     $   $   $       $$$$$   $

The Total Tree Multi-Product Cruise Program is designed to estimate
total tree, saw log, pulpwood, and firewood weight and volume of
forest stands from standing tree cruise data.  TTMPCP was developed
by the USDA Forest Service Southeastern Forest Experiment Station
in cooperation with the Georgia Forestry Commission and the Univer-
sity of Georgia School of Forest Resources.

                                                Version 1A - 12/84

Press space bar to continue.
```

The program options menu will appear after pressing the space bar. This screen lists the options available to the user.

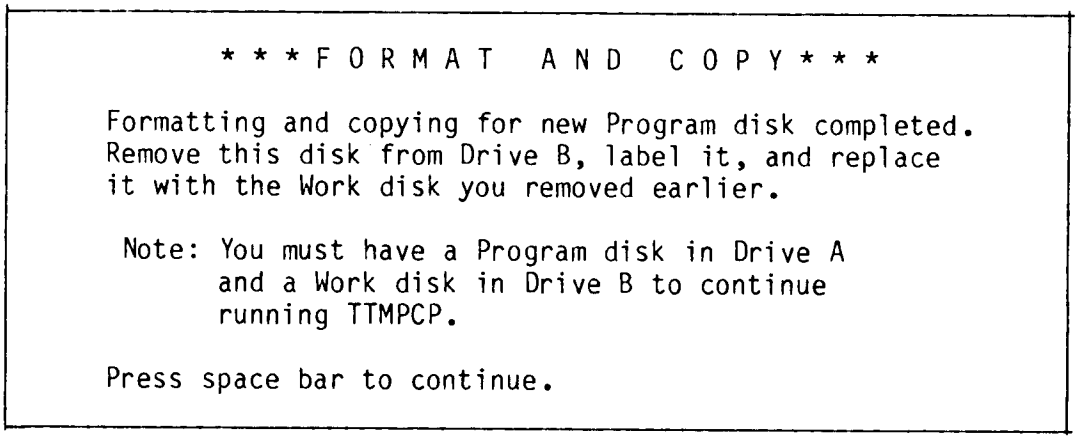


B(ack-up Program and/or Work Disks. The program has a built-in back-up (B) option that allows the user to format disks and make back-up copies of both the program disk and work disk. When the user purchases the TTMP Cruise Program, the royalty is paid to Softech Microsystems Inc. and NCI copyrights of the UCSD p-System. The user has the right to make two back-up copies of the program disk for use on the computer but does not have the right to reproduce the program for distribution. The user should make a back-up copy of the program and work disks and store the originals in a safe place before using the program.

To make back-up copies hit "B," and the following instructions will appear on the screen. Data entered by the user is shown in a box [ ] .

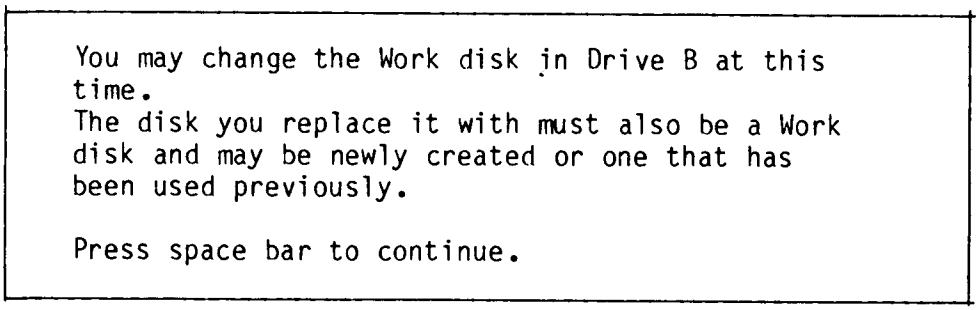


When format and copy are complete, the screen will display the following instructions.



To make a back-up of the work disk enter "B" and follow the instructions which appear on the screen. After making a copy of the work disk, replace it with a program disk in the A drive and then hit the space bar to continue. The program options menu will again appear on the screen.

R(eplace Work Disk. When the user wants to replace the work disk in the B drive with another work disk without rebooting, the "R" option for replacing work disks must be used. When "R" is pressed the following insructions will appear on the screen.



E(nter Cruise Data. To enter cruise data for a tract, press the "E" and the following table headings input screen will appear:

```
Listed below are headings that will appear on your output tables.
Please enter information as indicated by cursor.

LANDOWNER : JOHN DOE                          CASE NO : 16A

ADDRESS : ATHENS, GA                          DISTRICT NO : 14

TRACT LOCATION : GLYNN CO.                    TRACT SIZE (AC): 40

FORESTER : SMITH                              PHONE: 912-546-2441

ADDRESS : WAYCROSS, GA                  NO. AREAS CRUISED IN TRACT: 1

PHYSIOGRAPHIC REGION (T):  COASTAL             DATE (T):  84 / 12 / 09

Are you satisfied with the entries as shown? (Y or N) : Y
```

The user enters the heading information in the box describing the cruise and presses the enter key and the cursor moves to the next entry. The headings with a (T) are toggle entries. The user presses the space bar to toggle in the desired answer and then presses the enter key or carriage return to enter the selection into memory. For example, the toggle selections for physiographic region are Coastal, Piedmont, or Mountain. The year, month, and day are each toggle entries. The last question in this screen asks if the user is satisfied with the entries. If the user enters "N" for "no," the following edit instructions will appear at the top of the screen:

```
To correct entry indicated by cursor, press SPACE BAR and re-enter, or retoggle.
If entry is correct, a CARRIAGE RETURN moves cursor to the next entry.
```

When the user is satisfied with the tract heading entries and presses a "Y" for "yes," the screen for entering area information shown below will appear:

```
Enter the necessary information for Area  1, as indicated by the cursor.
For toggle questions (T) hit toggle (SPACE BAR) until appropriate answer
appears.  Press carriage return (CR) to accept entry.

ACREAGE : [ 40 ]                STAND ID./LOCATION : [ PINE-HARDWOOD ]

                                TYPE OF CRUISE (T) : PRISM

PRISM FACTOR (T):  10 BAF

NUMBER OF PLOTS : [ 40 ]                GROWTH PROJECTION (T): YES

YEARS PROJECED (T):   5                 INCREMENT CORE DATA ? (T): NO

Are you satisfied with the entries as shown? (Y or N) : [ Y ]
```

The user enters the acreage for the area and an alpha-numeric indentification or name for the area cruised. The type of cruise, blow-up factor, and number of plots entered in this screen are for all trees tallied or trees $\geq$ 5.0 inches d.b.h. if saplings were cruised differently. Cruise information for saplings tallied by a different cruise procedure will be entered later in the program. The toggle is used to select from fixed-area, prism, strip, or 100 percent tally for type of cruise. When selecting fixed-area cruise, the toggle is used to select the plot size--1/4, 1/5, 1/10, 1/20, 1/50, 1/100 acre, or other--and the user enters a radius in feet. For prism cruise, the toggle is used to select a prism basal-area factor (BAF) of 10, 5, or other, and the user enters a BAF factor. When entering fixed-area or prism cruises the user must enter the number of plots or points tallied in the area or the program will default to one plot or point. When strip cruise is selected, the user can enter the width and

cumulative length of the strip in feet or enter the percentage of the area in the strip. For growth projection, the toggle allows the user to enter "yes" or "no." If growth projection is requested, the toggle is used to select the number of years growth to be projected (1 to 5) and whether increment core measurements are to be entered for making growth projections. To obtain growth projections for one or more areas in a tract, growth projection must be requested for the first area entered.

At the bottom of this screen, the program asks if the user is satisfied with the entries. If the user enters "N," the following edit instructions will appear at the top of the screen:

```
To correct entry indicated by cursor, press SPACE BAR and re-enter, or retoggle.
If entry is correct, a CARRIAGE RETURN moves cursor to the next entry.
```

When the user is satisfied with the area information entries and presses "Y," the screen that allows the user to select the tree dimensions recorded during a cruise will appear as shown below:

TREE DIMENSIONS RECORDED DURING CRUISE AS CURRENTLY SET IN PROGRAM

SPECIES	TREE SIZE CLASS	DIMENSIONS MEASURED	STEM PULPWOOD TOP DOB (IN.)	DBH INTERVAL (IN.)	HEIGHT INTERVAL (FT./LOGS)
PINE	SAPLINGS	DBH		2	
PINE	PULPWOOD	D+H4	4	2	10
PINE	SAWTIMBER	D+MH	4	2	LOGS
H-HWD	SAPLINGS	DBH		2	
H-HWD	PULPWOOD	D+H4	4	2	5
H-HWD	SAWTIMBER	D+MH	4	2	LOGS
S-HWD	SAPLINGS	DBH		2	
S-HWD	PULPWOOD	D+H4	4	2	5
S-HWD	SAWTIMBER	D+MH	4	2	LOGS

Are you satisfied with the entries as shown? (Y or N) : [Y]

If the user is not satisfied with the preselected dimensions recorded as shown and presses "N," the following edit instructions will appear at the top of the screen:

```
Indicate (Y or N) if satisfied with line shown.
To correct entry indicated by cursor, press SPACE BAR to toggle responses.
If entry is correct, a CARRIAGE RETURN moves cursor to the next entry.
```

The screen showing tree dimensions recorded is edited a line at a time. If satisfied with the line indicated by the cursor press "Y," if not, press "N" and the cursor will move to the next entry in the line. All entries are a toggle. The d.b.h. or d.b.h. and height combinations under dimensions measured from which the user can select are listed on page 3 for each tree size class. For stem pulpwood d.o.b. top, the user can toggle-in 1 to 6 inches for pine or hardwood pulpwood and pine sawtimber and 1 to 8 inches for hardwood sawtimber. D.b.h. interval can be 1 or 2 inches and height interval can be 5 or 10 feet or 1/2 logs. The tree dimension selected must be the same for hard hardwoods and soft hardwoods except for the stem pulpwood top d.o.b.

When the user is statisifed with the entries for dimensions measured and presses "Y," the following screen showing default values for pounds per cord equivalents and sawtimber form class will appear:

```
DEFAULT VALUES FOR PINE, HARD HARDWOOD, AND SOFT HARDWOOD

                        POUNDS PER          SAWTIMBER
                      CORD EQUIVALENT      FORM  CLASS
================================================================

PINE  =>                  5600.00              78

H-HWD =>                  5700.00              78

S-HWD =>                  5700.00              78

================================================================

Are you satisfied with the entries as shown? (Y or N) : [Y]
```

If the user wants to change one or more of these preselected values and presses "N," the following edit instructions will appear at the top of the screen:

```
To correct entry indicated by cursor, press SPACE BAR and re-enter, or retoggle.
If entry is correct, a CARRIAGE RETURN moves cursor to the next entry.
```

The space bar is used to delete the current value indicated by the cursor and the user can enter values ranging from 4,000 to 8,000 for pounds per cord and form class values ranging from 65 to 90.

When the user is satisfied with the entries and presses "Y," the screen that allows the user to select output tables will appear as shown below:

```
                O U T P U T   T A B L E   O P T I O N S

    ==================================================================
                                     ESTIMATE
                           PER ACRE                 PER AREA
    ==================================================================
    TABLE 1-- BD FT BY DBH CLASS
      DOYLE
      SCRIBNER                                         Y
      INT. 1/4

    TABLE 2-- TREE COMPONENT BY DBH CLASS
      TONS                                             Y
      CORDS                                            Y
      CUNITS

    TABLE 3-- SUMMARY TABLE
      CURRENT                                          Y
      PROJECTED                                        Y
    ==================================================================
    Are you satisfied with the entries as shown? (Y or N) : [Y]
```

If the user is not satisfied with the preselected output tables as shown and presses "N," the following edit instructions will appear at the top of the screen:

```
To correct entry indicated by cursor, press SPACE BAR and re-enter, or retoggle.
If entry is correct, a CARRIAGE RETURN moves cursor to the next entry.
```

Examples of Tables 1, 2, and 3 are shown on pages 43, 44, and 46, respectively. The user can have a table printed on a per acre or per area basis, or both. This screen also allows the user to select the board-foot rules to be used to estimate board-foot volumes shown in Table 1, the units of measure to be displayed in Table 2, and if Table 3 is to be printed showing current and projected estimates. The space bar is used to toggle a "Y" if the user wants the table printed, or a blank if the user does not want it printed.

When the user is satisfied with the entries and presses "Y," the screen allowing the user to select the species tallied in the cruise will appear as shown below:

```
Listed below are the tree species for which tree compo-
nent weight and volume equations are available for the
Coastal  region.  Indicate those tallied in Area 1 with
a Y(es.  Press N(o or <SP> to continue through list.

   PINE------------->   X    PLANTATION PINE------>

   HARD HARDWOODS--->   X    CYPRESS-------------->

   SOFT HARDWOODS--->   X

   OAK SP.---------->

   LIVE OAK--------->

   SWEEETGUM-------->

   PINE2------------>

   SAND PINE-------->

Are you satisfied with the selections made above? (Y or N) : [Y]
```

The species or species groups available for each physiographic region are shown on pages 5 to 7. The user can select up to six species or species groups per area and a total of nine per tract. The user presses "Y" if a species is tallied and "N," if not. If the user is not satisfied with the entries and presses "N," the species selections are deleted and the selection process starts over.

When the user is satisfied with his species selections and presses "Y," the additional options screen will appear as shown below:

```
                ADDITIONAL PROGRAM OPTIONS

                   Respond Y(es or N(o

  => Were saplings cruised using a method different
     from that used in cruising pulpwood/sawtimber? [ N ]
```

If the user cruised saplings differently than trees $\geq$ 5.0 inches d.b.h. the program will ask for the type of cruise used and for information related to the cruise, such as prism factor or plot radius and number of points or plots on which saplings were tallied. The cruise information originally entered for the area is assumed to apply to the trees $\geq$ 5 inches d.b.h.

After completing the above question the following option question will appear:

```
  => Do you desire the sawlog stem, for natural pine,
     to be separated into plylogs and small sawlogs? [ Y ]
```

When the user answers "yes," the following questions will appear on the screen:

```
  For the calculation of plylog weights and volumes, enter
 the following tree dimension information:
                                        DEFAULT    LOWEST ACCEPTABLE
                                         VALUE           VALUE
  Minimum d.b.h. class (in.): [ 14 ]      13.0            11.0

  Minimum d.o.b.       (in.): [ 10 ]      10.0             8.0

  Enter a <CR> is you wish to use the default value.
```

The user can then enter the minimum d.b.h. tree from which plylogs can be cut and minimum d.o.b. top to which they can be harvested, or enter a <CR> to use the default values.

After answering the above question, a third question will appear if two or more areas have been cruised within a tract:

```
=> Do you wish to have Table 3 printed on a
     tract level (i.e. over all areas cruised)?
```

When the user answers "Y," Table 3A will be printed summarizing all areas in the tract. Table 3B will also be printed summarizing board-foot volumes across all areas.

When the user tallies plantation pine, the following question will appear:

```
=> Do you wish chipping-sawlog output for planta-
     tion pine species?                              [Y]
```

If the user enters "Y," the following questions will appear:

```
For the calculation of chipping-sawlog weight and volumes, enter
the following tree dimension information:

                                    DEFAULT     LOWEST ACCEPTABLE
                                     VALUE           VALUE
Minimum d.b.h. class (in.): [7]      8.0             6.0

Minimum d.o.b.       (in.): [6]      6.0             5.0

Enter a <CR> is you wish to use the default value.
```

The user can then enter the minimum d.b.h. tree from which chipping sawlogs can be cut and the minimum d.o.b. top to which they can be harvested, or enter a <CR> to use the default values.

After answering the option questions, the user is asked to enter area cruise data by species and tree size class. The program asks that sapling tallies be entered first as shown for the example cruise on pages 11 and 12.

```
INPUT:  N(o data, <SP> accepts entry, <CR> returns for new dbh, E(nd of input

                        PINE - SAPLINGS (<= 4.0 IN.)
   DBH      TREE COUNT

?  2              6
?  4             18
?  E
```

To enter the pine tree counts for saplings tallied by d.b.h. only, the user enters the d.b.h. class, presses the space bar and the cursor moves under the "tree count" heading. The user then enters the count and presses the carriage return. To end the sapling input, the user presses "E." If no saplings were tallied the user would press the "N" for no data.

After entering the sapling counts and pressing "E," the screen for inputing pine pulpwood tree counts will appear as shown below:

```
INPUT:  N(o data, <SP> accepts entry, <CR> returns for new dbh, E(nd of input

                          PINE - PULPWOOD (>= 5.0 IN.)
                              HT. TO 4 IN. TOP(FT.)
 DBH  10   20   30   40   50   60   70   80   90   100  110  120  130  140

? 6    4    11   12
? 8         6    17   27   8
? 12                  2    1
? 16                       2
? E
```

To enter tree counts for pine pulpwood tallied by d.b.h. and height to 4-inch top, the user enters the d.b.h. class and then moves the cursor using the space bar under each height class for which trees were tallied, and enters the appropriate counts. After entering the counts for a d.b.h. class, the user presses the carriage return and the question mark appears on the next line under d.b.h. asking the user to enter the next d.b.h. class for which trees were tallied.

After entering the pulpwood counts and pressing "E," the screen for inputing pine sawtimber will appear as shown below:

```
INPUT:  N(o data, <SP> accepts entry, <CR> returns for new dbh, E(nd of input

                          PINE - SAWTIMBER (>= 9.0 IN.)
                              MERCAHNTABLE HT. (LOGS)
 DBH  0.5  1.0  1.5  2.0  2.5  3.0  3.5  4.0  4.5  5.0  5.5  6.0

? 10        5    20   20   1
? 12        2    16   25   8
? 14             16   12
? 16             2    15   14
? 18             1    2    3    1
? 20             1    4    4    1
? E
```

After entering the appropriate pine sawtimber counts by d.b.h. and height classes and pressing "E," the program will display the d.b.h. and counts as entered for each tree size class and ask if the user is satisfied with the entries. If the user enters "N," the following edit instructions will appear at the top of the screen.

```
EDIT:  N(o changes, <SP> to change line, D(elete line, A(dd to current input
```

The tree count input screens are edited a line at a time. If the user does not want to make a change for a d.b.h. class, "N" is pressed and the cursor will move to the next d.b.h. class. If the user wants to change the counts entered for a d.b.h. class, the space bar is pressed to delete the counts entered. The user then reenters the counts for the d.b.h. class and presses the carriage return. If the user wants to delete both the d.b.h. and the counts, "D" is pressed and then the d.b.h. and appropriate counts are reentered. If the user wants to add additional d.b.h. classes and counts, "A" is pressed.

After editing the tree tally for a size class, the program will display the tree counts again and ask if the user is satisfied. If the user is satisfied the program will calculate the estimated weights and volumes for the species counts entered and store them on the work disk. The program will then ask the user to input the counts for the next species tallied. For the example in this manual, the program would ask for the hard hardwood tally input and then the soft hardwood input.

If the user indicated that pine increment-core measurements were to be entered, the following instructions would appear on the screen after the counts for pine are entered:

```
                PINE INCREMENT CORE MEASUREMENTS

Enter dbh of bored trees to nearest tenth of an inch followed
by the radial growth of the last 5 years to the nearest hun-
dredth of an inch.  Separate measurements with a blank.  Signal
end of input with an E(nd <CR>.  If no data was collected for a
tree class, enter N(one <CR>.  Enter data:

FOR AVERAGE PULPWOOD TREES (5.0 TO 8.9 INCHES):

    ? 6.2 .32
    ? 7.5 .42
    ? 8.9 .42
    ? 6.8 .42
    ? 8.1 .37
    ? E
```

The user enters the d.b.h., a space, and the width of the last 5 years' growth excluding bark. If the entries are satisfactory, the user will be asked to enter measurements for the sawtimber-size trees. If not satisfied, the entries will be deleted and the user can reenter the correct measurements.

After entering the tree counts for each species and the increment-core measurements if measured, the program menu (page 14) will appear on the screen.

P(rint Output Tables for Tract. The weight and volume estimates for each cruise entered are stored on the work disk in the cruise data file. To print the output tables for a cruise, the user presses "P" and the following table will appear summarizing the tracts stored in the cruise data file:

Tract(s) currently residing in cruise data file:

NUMBER	CASE	LANDOWNER	LOCATION	DATE
1	16A	JOHN DOE	GLYNN CO., GA	84/12/09

Enter the number of the tract for which output
is desired or "0" if no output is desired------> 1

The tracts listed in the cruise data file are numbered sequentially according to the order they are entered into the program. The listing also shows the case number, landowner's name, tract location, and date of entry based on the table heading information entered for each cruise. To print the output tables for a tract, the user enters the number of the tract to be printed and presses the carriage return.

While the tables are being printed the program menu of options will appear on the screen because the program has a 50K print buffer. This allows the user to enter another cruise while output tables are being printed. The user should not use the back-up option while printing from the buffer since this can damage the disk being copied.

D(elete a Tract from the Cruise Data File. After output tables for a tract have been printed and the tract information is no longer needed, the user can delete the tract from the work disk cruise data file by using the Delete option. When "D" is pressed the following table summarizing the tracts in the cruise data file will appear on the screen:

Tract(s) currently residing in cruise data file:

NUMBER	CASE	LANDOWNER	LOCATION	DATE
1	16A	JOHN DOE	GLYNN CO., GA	84/12/09

Enter the number of the tract you wish to delete
or "0" if no deletion is desired---------------> 1

To delete a tract the user enters the number of the tract and presses the carriage return. After deleting a tract, the menu of options will appear on the screen. To efficiently use the storage space on the work disk, the user should compress the cruise data file after deleting one or more tracts.

C(ompress Cruise Data File. The compress option is used to make storage space once occupied by deleted files available to store additional files. To compress the cruise data file the user presses "C" and the following will appear on the screen:

```
                    *** C O M P R E S S I N G ***

*** 2 records for a tract placed in temporary scratch file ***

              *** RE-INITIALIZING CRUISE DATA FILE ***
      Records being initialized:.................
*** 2 records for a tract transferred back into cruise data file ***
       *** 1 deleted tract(s) removed from cruise data file ***

            *** C O M P R E S S   C O M P L E T E D ***
                  Press space bar to continue.
```

The compress option copies the records of the tracts not deleted in the file to a temporary scratch file. It then initializes the cruise data file and transfers the tract files back to the cruise data file, eliminating any unused records occurring between tract records. When the Compress has been completed, the user presses the space bar and the program options menu will appear.

The cruise data file on the work disk contains 48 records which can be used for storing cruise output data. If more than 48 records are written to this file, a file overflow will occur which can destroy track information on the work disk. When the user has used 24 of these records to store track output estimates, the following warning will appear on the screen:

```
Warning:  You have 22 records in the cruise data file available
          for storing inventory data.

          The records currently in use consist of:
              6 printable and deletable tract(s), and
              0 tract(s) which have been deleted and need to
                be removed.

          If the number of areas PLUS the number of separate tree
          species tallies to be entered for your tract is greater
          than or equal to 22, a file overflow may occur.

          Enter " Y " if you are satisfied that there is sufficient
           room in the cruise data file for your timber cruise.
          Enter " N " for a description of the alternatives available
           to you for increasing the space on your work disk.
       ?
```

If the user presses "Y" the program will continue with the cruise data input option. If the user presses "N," the following instructions will appear:

```
    The records currently in use consist of:
        6 printable and deletable tracts(s), and
        0 tracts(s) which have been deleted and need to
          be removed

    Recommended options(s) for freeing space in the cruise data file:

    1 - D(elete unwanted tract(s) from cruise data file, AND then

    2 - C(ompress cruise data file.

        Press space bar to continue.
```

When the user presses the space bar, the menu options will appear and the user can select the D(elete or C(ompress options as instructed.

T(erminate Program. The "T" option must be used to close the files on the work disk when terminating the program. To terminate the program the user presses "T," and the following instructions will appear on the screen:

```
        Total Tree Multi-Product Cruise Program terminated.

        Press <Ctrl> <Alt> <Del> to restart program or
        remove disks from drives
```

Mainframe Example

The mainframe version is an interactive program designed to use remote terminals for input to produce output at the terminal or routed to a line printer. The user provides information by answering prompted questions and by entering a cruise summary of tree counts by species or species groups. When entering a cruise the user has the choice of using preselected options stored in the program (Appendix B) or of answering option questions to meet the user's specific needs. How to answer option questions is illustrated in the following example, which also shows the versatility of the program. Mandatory questions that must be answered for each cruise when preselected options are used and no growth estimates are needed are indicated by an asterisk (*).

Logon. The TTMP Cruise Program is stored on a mainframe in compiled object code and a user needs the phone number for the computer, a user ID, and password to access the program. The logon procedures are slightly different at each installation. See local instructions for logon. After logon, the user selects the appropriate procedure depending on whether the output is routed to the terminal or a line printer. A programmer's guide describing the mainframe FORTRAN V code, subroutines, and procedures used to compile and execute the program is available upon request from the authors.

Enter Cruise Data. After the user calls TTMP Cruise Program with the appropriate procedure, the program will start. The user answers each question as it appears after the question mark (?) and hits the carriage return (CR) at the end of each entry. After each line of data is entered it will be printed or echoed back at the terminal. The data entered by the user are shown in a box [ ].

```
WELCOME TO THE TOTAL TREE MULTI-PRODUCT CRUISE PROGRAM-- AN ADP
PROGRAM FOR ESTIMATING TOTAL TREE, SAW LOG, PULPWOOD AND FIREWOOD
WEIGHTS AND VOLUMES FROM STANDING TREE CRUISE DATA. TTMPCP WAS
DEVELOPED BY THE USDA FOREST SERVICE SOUTHEASTERN FOREST EXPERIMENT
STATION IN COOPERATION WITH THE GEORGIA FORESTRY COMMISSION AND THE
UNIVERSITY OF GEORGIA SCHOOL OF FOREST RESOURCES.
```

```
* 1.  ENTER THE FOLLOWING ON ONE LINE -- SEPARATE WITH COMMAS:
          DISTRICT NUMBER,
          CASE NUMBER,
          LANDOWNER NAME, AND
          OWNER ADDRESS.
   ? 14,16A,JOHN DOE,MAIN ST ATHENS GA 30602  CR
     14,16A,JOHN DOE,MAIN ST ATHENS GA 30602

* 2.  ENTER THE FOLLOWING ON ONE LINE -- SEPARATE WITH COMMAS:
          PHYSIOGRAPIC REGION (2 = COASTAL, 4 = PIEDMONT, 6 = MOUNTAIN),
          ACREAGE IN TOTAL TRACT,
          NUMBER OF AREAS CRUISED SEPARATELY WITHIN TRACT,
          TRACT LOCATION,
          FORESTERS NAME,
          FORESTERS ADDRESS, AND
          FORESTERS PHONE NUMBER.
   ? 2,40,1,GLYNN CO,SMITH,WAYCROSS GA,912-546-2441  CR
     2,40,1,GLYNN CO,SMITH,WAYCROSS GA,912-546-2441

* 3.  ENTER THE FOLLOWING FOR AREA 1:
        ACREAGE,
        TYPE OF CRUISE (1=FIXED AREA PLOT, 2=POINT SAMPLE, 3=STRIP CRUISE,
         4=100% CRUISE),
        NUMBER OF PLOTS SAMPLED OR '1' IF STRIP OR 100% CRUISE USED,
        TYPE OF STAND ( 1=NATURAL, 2=PLANTATION), AND
        AREA IDENTIFICATION AND/OR LOCATION.
      SEPARATE EVERYTHING BY COMMAS.
   ? 40,2,40,1,PINE-HARDWOOD  CR
     40,2,40,1,PINE-HARDWOOD

*    DO YOU WANT GROWTH PROJECTION? (Y OR N)
   ? YES  CR
     YES
          (To obtain growth projections for one or more areas in a track,
           growth projection must be requested for the first area entered.)

      ENTER NUMBER OF YEARS GROWTH IS TO BE PROJECTED (5 YEARS MAX)
   ? 5  CR
     5
        (The number of years' growth projected for Area 1 is used for all
         areas in a tract for which growth is requested.)

      IS INCREMENT CORE DATA TO BE ENTERED FOR GROWTH
      PROJECTION?  (Y OR N)
   ? NO  CR
     NO

      IDENTIFY BOARD-FOOT RULES TO BE USED IN ESTIMATING PROJECTED BOARD-FOOT
      VOLUMES FOR SPECIES CRUISED IN TRACT (SAME RULES USED FOR
      ALL AREAS).  ENTER SPECIES CODE:

      (Since the board-foot rules used to calculate percent growth for each
       species group must be the same for all areas to allow for calculation
       of tract totals this question must be answered for the tract during
       input for Area 1.)
```

PINE=1, HARD-HARDWOOD=2, SOFT-HARDWOOD=3, OAK SP.=4, LIVE OAK=5,
SWEETGUM=6, PINE2=7, SAND PINE=8, PLANT PINE=9, CYPRESS=10.

FOLLOWED BY CODE FOR BOARD-FOOT RULE (DOYLE=1, SCRIBNER=2,
INTERNATIONAL 1/4=3). SEPARATE ALL ENTRIES BY A COMMA.
ENTER CODES BY ONE SPECIES PER LINE. SIGNAL END OF INPUT
WITH AN 'END'.
ENTER: SPECIES, BD.-FT. RULE

? 1,2 CR
1,2

? 2,1 CR
2,1

? 3,1 CR
3,1

? END CR
END

IF YOU DESIRE CHIPPING SAW ESTIMATES, ENTER 'YES' FOLLOWED BY
MINIMUM CHIPPING SAW TREE DBH AND TOP DIAMETER. SEPARATE ENTRIES
WITH A COMMA. IF YOU DO NOT DESIRE CHIPPING SAW ESTIMATES,
ENTER 'NO'. DEFAULT IS NO; MINIMUM CHIPPING SAW DBH ACCEPTED
IS 6-INCHES, DEFAULT IS 8-IN.; MINIMUM TOP DOB ACCEPTED IS 5-INCHES,
DEFAULT IS 6-IN.

? YES,8,6 CR
YES,8,6

(The above question is displayed only when entering plantation cruise data.)

TOTAL TREE MULTI-PRODUCT CRUISE PROGRAM

LANDOWNER - JOHN DOE
ADDRESS - MAIN ST ATHENS GA 30602
TRACT LOC. - GLYNN CO
FORESTER - SMITH
ADDRESS - WAYCROSS GA
PHYSIOGRAPHIC REGION - COASTAL

CASE NO. - 16A
DISTRICT NO. - 14
TRACT SIZE(AC) - 40.00
PHONE - 912-546-2441
DATE - 84/12/09

NO. AREAS CRUISED IN TRACT - 1

AREA - 1 ACREAGE - 40.00 STAND ID - PINE-HARDWOOD
TYPE OF CRUISE - POINT BLOW-UP FACTOR - 10.00 STAND TYPE - NATURAL
NUMBER OF PLOTS - 40 GROWTH PROJECTION - YES
YEARS PROJECTED - 5 INCREMENT CORES - NO

* THE ABOVE INFORMATION SUMMARIZES THE GIVEN INPUT FOR
AREA 1. IF YOU ARE SATISFIED WITH THE ENTRIES YOU
MADE, ENTER 'YES'. IF YOU ARE NOT SATISFIED WITH ANY OF
THIS INFORMATION, ENTER THE QUESTION NUMBERS (1,2, OR 3) YOU
WISH TO CHANGE. MAKE SURE TO SEPARATE BY COMMAS.
? YES CR
YES

(If 1, 2 or 3 is entered, question 1, 2 or 3 will be repeated so it
can be answered correctly.)

* 4. PRESELECTED PROGRAM OPTIONS HAVE BEEN STORED FOR THE MOST COMMONLY USED TREE DIMENSIONS AND PREFERRED OUTPUT TABLES BY STAND TYPE AND CRUISE OBJECTIVE AS OUTLINED IN USER MANUAL. IF YOU DO NOT WANT TO USE THE PRESELECTED OPTIONS, ENTER 'NO'. IF YOU WANT TO USE THE PRESELECTED OPTIONS, ENTER 'YES' FOLLOWED BY THE CODE FOR TYPE OF STAND CRUISED:

1=NATURAL PINE, 2=PLANTED PINE, 3=HARDWOOD OR PINE-HARDWOOD

FOLLOWED BY CODE FOR PURPOSE OF CRUISE:

1=TIMBER SALE, 2=MANAGEMENT PLAN, 3=DETAILED CRUISE

SEPARATE ENTRIES WITH COMMAS.

? NO CR
NO

(When preselected options are used the program will immediately ask for cruise data entry (page 39). See Appendix B for preselected cruise options.)

PRESELECTED DIMENSIONS MEASURED, CRUISE PARAMETERS, & OUTPUT TABLES

SPECIES	SIZE CLASS	DIMENSIONS MEASURED	STEM PULPWOOD TOP DOB (IN.)	DBH INTERVAL (IN.)	HEIGHT INTERVAL (FT./LOGS)
PINE	SAPLINGS	DBH		2	
PINE	PULPWOOD	D+H4	4	2	10
PINE	SAWTIMBER	D+MH	4	2	LOGS
H-HWD	SAPLINGS	DBH		2	
H-HWD	PULPWOOD	D+H4	4	2	10
H-HWD	SAWTIMBER	D+MH	4	2	LOGS
S-HWD	SAPLINGS	DBH		2	
S-HWD	PULPWOOD	D+H4	4	2	10
S-HWD	SAWTIMBER	D+MH	4	2	LOGS

	POUNDS PER CORD EQUIVALENT	SAWTIMBER FORM CLASS
PINE =	5600.0	78.
H-HWD =	5700.0	78.
S-HWD =	5700.0	78.

OUTPUT TABLES

	ESTIMATE PER ACRE	PER AREA
TABLE 1		Y
A. DOYLE		Y
B. SCRIBNER		Y
C. INT. 1/4		
TABLE 2		Y
A. TONS		
B. CORDS		Y
C. CUNITS		
TABLES 3A & 3B		
CURRENT		Y
PROJECTED		Y

AS SHOWN IN THE TABLES ABOVE, TTMPCP HAS STORED PRESELECTED CRUISE PARAMETERS AND OUTPUT OPTIONS. ENTER 'YES' IF YOU WANT TO USE THESE STORED INPUT AND OUTPUT OPTIONS. ENTER 'NO' IF YOU WANT TO CHANGE ONE OR MORE OF THE STORED OPTIONS.

? NO CR
NO

MENU OF OPTION QUESTIONS

6. CHANGE CRUISE BLOW-UP FACTOR
7. CHANGE POUNDS PER CORD EQUIVALENTS
8. CHANGE TREE DIMENSIONS MEASURED AND CRUISE PARAMETERS
9. SELECT PLYLOG AND SMALL SAWLOG OUTPUT
10. SELECT TABLE 1, SAWLOG BD. FT. VOLUME BY DBH, AND BD. FT. RULE(S) USED IN TABLE 1
11. SELECT TABLE 2, TREE COMPONENT BIOMASS BY DBH, AND UNITS OF MEASURE FOR TABLE 2
12. CHANGE SAWTIMBER FORM CLASS
13. SELECT TABLES DESIRED FOR PER ACRE, PER AREA, AND FOR TRACT OUTPUTS
14. SELECT BASAL AREA OUTPUT

5. ENTER NUMBER(S) OF QUESTIONS YOU WANT TO ANSWER OR 'ALL' IF YOU WANT TO ANSWER ALL QUESTIONS. SEPARATE NUMBERS WITH COMMAS.

? ALL CR
ALL

6. THE USER MAY CHANGE THE TYPE OF CRUISE AND/OR A CRUISE SPECIFICATION (I.E. PLOT AREA, PRISM FACTOR, ETC.) FROM WHAT WAS PREVIOUSLY SPECIFIED BY THE USER OR BY DEFAULT. ALSO, A CRUISE TYPE MAY BE SPECIFIED FOR SAPLINGS (TREES < 5.0 INCHES). ENTER 'NO' IF NO CHANGES REQUIRED. ELSE ENTER TREE SIZE CODE (1= SAPLINGS, 2= TREES>= 5-IN., 3= ALL TREES), FOLLOWED BY TYPE OF CRUISE (1= FIXED AREA, 2= POINT, 3= STRIP, 4= 100%). LIST ALL CODES IN ONE INPUT STRING SEPARATED BY COMMAS.

NOTE: IF A TYPE OF CRUISE IS SPECIFIED FOR SAPLINGS, THE USER MUST ALSO ENTER A TYPE FOR THE CLASS OF TREES>= 5-IN. (AND VICE VERSA).

? 1,1,2,2 CR
1,1,2,2

(In this example saplings (1) were tallied by using fixed area (1) and trees ≥ 5 inches (2) were tallied by using a point cruise (2).)

ENTER RADIUS OF PLOT IN FEET FOR FIXED AREA PLOT USED TO CRUISE SAPLINGS:
? 16.65 CR
16.65

(The user enters the radius of the plot in feet. Listed below are some commonly used circular plot radii, in feet:)

1/4 acre = 58.55	1/10 acre = 37.23	1/50 acre = 16.65
1/5 acre = 52.66	1/20 acre = 26.33	1/100 acre = 11.78

ENTER NUMBER OF PLOTS USED IN CRUISING SAPLINGS:
? 10 CR
10

ENTER PRISM FACTOR FOR POINT SAMPLE CRUISE USED TO TALLY TREE>=5 IN:
? 10 CR
10

ENTER NUMBER OF POINTS USED IN CRUISING TREE>=5 IN:
? 40 CR
40

(If a strip cruise is used, program will ask for two entries.)

ENTER WIDTH OF STRIP OR PERCENT OF AREA CRUISED:
? 66 CR
66

(User enters width of strip in feet or percent of area cruised.)

```
ENTER TOTAL LENGTH OF STRIP OR 0 IF PERCENT OF AREA CRUISED
ENTERED ABOVE:
? [2000] CR
   2000
```

(User enters total length of strip in feet or zero.)

```
7.  THESE ARE THE POUND/CORD EQUIVALENTS FOR YOUR PHYSIOGRAPHIC AREA:
      PINE IS                5600.0
      HARD-HARDWOOD IS       5700.0
      SOFT-HARDWOOD IS       5700.0

IF YOU ARE SATISFIED, ENTER 'YES'; IF NOT, ENTER THE DESIRED CHANGES.
ENTER SPECIES (1=PINE, 2=HARD-HARDWOOD, 3=SOFT-HARDWOOD), COMMA,
FOLLOWED BY ITS POUND/CORD EQUIVALENT.
ENTER 'END' TO SIGNAL THE END OF CHANGES.
? [2,5750] CR
   2,5750
? [3,5750] CR
   3,5750
? [END] CR
   END

8.  IN THIS SECTION YOU CAN SPECIFY THE DIMENSIONS MEASURED, THE PULP-
    WOOD TOP DIAMETER, AND THE HEIGHT AND DBH INTERVAL USED IN TALLYING
    A GIVEN SIZE CLASS.  IT IS ASSUMED HARD-HARDWOOD AND SOFT-HARDWOOD
    HAVE THE SAME DIMENSIONS EXCEPT FOR STEM PULPWOOD TOP DOB.
ENTER: THE SIZE CLASS (1=SAPLING, 2=PULPWOOD, 3=SAWTIMBER)
       DIMENSIONS MEASURED (1=DBH, 2=DBH & TH, 3=DBH & HT4, 4=DBH & MHT,
        AND 0=NOT MEASURED),
       STEM PULPWOOD TOP DOB (MAX. DOB: PINE=6 IN., HARDWOOD=8 IN., OR
        0=NONE),
       DBH INTERVAL (1=1 INCH, 2=2 INCH),
       AND HEIGHT INTERVAL (5=5 FT., 10=10 FT., AND 0=NOT MEASURED OR LOGS),
       SEPARATED BY COMMAS--ONE SIZE CLASS PER LINE.
    NOTE: IF THERE ARE NO DATA FOR A SIZE CLASS, ENTER THE SIZE
          CLASS CODE AND A '0', SEPARATED BY A COMMA.
    IF SATISFIED WITH THE STORED PARAMETERS, ENTER 'YES' ELSE ENTER 'NO'
    AND YOU WILL BE PROMPTED BY SPECIES.
? [NO] CR
   NO

ENTER DESIRED PINE CHANGES.  IF NO CHANGES NEEDED, ENTER 'NONE'.  SIG-
NAL END OF INPUT STREAM WITH AN 'END'.
  ENTER: SIZE CLASS, DIMENSION MEASURED, PULP TOP DOB, DBH INTERVAL,
         HEIGHT INTERVAL.
? [NONE] CR
   NONE
```

```
ENTER DESIRED HARD-HARDWOOD CHANGES.  IF NO CHANGES NEEDED, ENTER 'NONE'.
SIGNAL END OF INPUT STREAM WITH AN 'END'.
  ENTER: SIZE CLASS, DIMENSION MEASURED, PULP TOP DOB, DBH INTERVAL
         HEIGHT INTERVAL.
? 1,1,0,2,0   CR
  1,1,0,2,0
? 2,3,4,2,10  CR
  2,3,4,2,10
? 3,4,5,2,0   CR
  3,4,5,2,0
? END   CR
  END

ENTER DESIRED SOFT-HARDWOOD CHANGES.  THE ONLY DIFFERENCE BETWEEN
HARD-HARDWOOD AND SOFT-HARDWOOD PERMITTED IS STEM PULPWOOD TOP DOB.
IF HARD AND SOFT-HARDWOOD PULP TOP DOB IS THE SAME, ENTER 'SAME'. IF
A DIFFERENT PULP TOP DOB IS USED FOR SOFT-HARDWOOD ENTER THE SIZE CLASS,
COMMA, AND THE TOP DOB DESIRED.  SIGNAL END OF INPUT STREAM WITH AN 'END'.
? 3,4   CR
  3,4
? END   CR
  END

9.  IF YOU DESIRE SAW-LOG STEM DIVIDED INTO PLYLOGS AND SMALL SAW LOGS,
    ENTER 'YES' FOLLOWED BY MINIMUM PLYLOG DBH CLASS FOLLOWED BY MINIMUM UP-
    PER STEM PLYLOG DOB.  SEPARATE ENTRIES WITH A COMMA.  IF YOU DO NOT
    DESIRE PLYLOG ESTIMATES, ENTER 'NO'.  DEFAULT IS NO; MINI-
    MUM PLYLOG DBH ACCEPTED IS 11-IN., DEFAULT IS 13-IN.,: MINIMUM PLYLOG
    TOP DOB ACCEPTED IS 8-IN., DEFAULT IS 10-IN.
? YES,14,10   CR
  YES,14,10

10. TABLE 1 - GROSS SAW-LOG BOARD-FOOT VOLUME BY
    D.B.H. CLASS - IS OPTIONAL.
    DO YOU WANT TABLE 1 (YES OR NO)?
? YES   CR
  YES

    WHAT BOARD FOOT RULE DO YOU DESIRE FOR TABLE 1?
    ANY OR ALL OF THE FOLLOWING ARE AVAILABLE:
      1=DOYLE, 2=SCRIBNER, 3=INTERNATIONAL 1/4
    ENTER THE CODES SEPARATED BY COMMAS OR 'SAME' IF YOU
    WISH TO USE THE PRESTORED LOG RULE OPTION.
? 1,2   CR
  1,2
        (See Appendix B for prestored options.)

11. TABLE 2 - TREE COMPONENT BIOMASS BY D.B.H. CLASS - IS OPTIONAL.
    DO YOU WANT TABLE 2 (YES OR NO)?
? YES   CR
  YES
```

```
WHAT UNITS OF MEASURE DO YOU DESIRE FOR TABLE 2?
ANY OR ALL OF THE FOLLOWING ARE AVAILABLE:
  1=TONS(DEFAULT), 2=CORDS, 3=CUNITS
ENTER THE CODES SEPARATED BY COMMAS OR 'SAME' IF YOU
WISH TO USE THE PRESTORED UNITS.
? 1,2,3  CR
  1,2,3
```

12. SAWTIMBER FORM CLASS--ENTER SPECIES (1=PINE, 2=HARD-HARDWOOD, 3=SOFT-HARDWOOD) FOLLOWED BY ITS FORM CLASS
ONE SPECIES TO A LINE--ENTER 'END' AT END OF INPUT.
IF ALL SPECIES HAVE THE SAME FORM CLASS, ENTER 'ALL', COMMA, AND THE FORM CLASS.

```
? ALL,78  CR
  ALL,78
```

13. ENTER THE NUMBERS OF ALL THE TABLES YOU WISH TO HAVE ON A PER ACRE BASIS (1,2,3) SEPARATED BY COMMAS, OR 'NONE'. ENTER 'SAME' IF YOU WISH TO USE THE PRE-STORED FORMAT.

```
? 1,2,3  CR
  1,2,3
```

(See pages 43, 44, and 46 for examples of Tables 1, 2, and 3.)

```
ENTER THE NUMBERS OF ALL THE TABLES YOU WISH TO
HAVE ON A PER AREA BASIS (1,2,3) SEPARATED BY COMMAS,
OR 'NONE'.  ENTER 'SAME' IF YOU WISH TO USE THE PRE-
STORED FORMAT.
? NONE  CR
  NONE

ENTER CODES SPECIFYING TABLES YOU WISH TO HAVE PRINTED
ON A TRACT BASIS:

 (1=CURRENT SUMMARY (TABLE 3), 2=PROJECTED SUMMARY,
  3=GROWTH SUMMARY (TABLE 4)).

SEPARATE CODES WITH COMMAS.
IF NONE DESIRED, ENTER "NONE".
? 1,2,3  CR
  1,2,3
```

14. ENTER 'YES' IF YOU WANT BASAL AREA INFORMATION OR 'NO' IF NOT.

```
? YES  CR
  YES
```

(After answering option questions, the tables summarizing options are reprinted to show current parameters.)

PRE-SELECTED DIMENSIONS MEASURED, CRUISE PARAMETERS, & OUTPUT TABLES

SPECIES	SIZE CLASS	DIMENSIONS MEASURED	STEM PULPWOOD TOP DOB (IN)	DBH INTERVAL (IN)	HEIGHT INTERVAL (FT/LOGS)
PINE	SAPLINGS	DBH		2	
PINE	PULPWOOD	D+H4	4	2	10
PINE	SAWTIMBER	D+MH	4	2	LOGS
H-HWD	SAPLINGS	DBH		2	
H-HWD	PULPWOOD	D+H4	4	2	10
H-HWD	SAWTIMBER	D+MH	4	2	LOGS
S-HWD	SAPLINGS	DBH		2	
S-HWD	PULPWOOD	D+H4	4	2	10
S-HWD	SAWTIMBER	D+MH	4	2	LOGS

	POUNDS PER CORD EQUIVALENT	SAWTIMBER FORM CLASS
PINE =	5600.0	78.
H-HWD =	5700.0	78.
S-HWD =	5700.0	78.

OUTPUT TABLES

	ESTIMATE PER ACRE	PER AREA
TABLE 1	Y	
A. DOYLE	Y	
B. SCRIBNER	Y	
C. INT. 1/4		
TABLE 2	Y	
A. TONS	Y	
B. CORDS	Y	
C. CUNITS	Y	
TABLES 3A & 3B		
CURRENT	Y	
PROJECTED	Y	

ENTER 'YES' IF THE CHANGES YOU HAVE MADE ABOVE ARE CORRECT. IF NOT, ENTER 'NO' AND YOU WILL BE PROMPTED FOR CORRECTIONS TO BE MADE.

? YES CR
YES

* THIS IS THE CRUISE DATA INPUT SECTION FOR AREA 1.

IDENTIFY THOSE SPECIES GROUPS FOR WHICH CRUISE DATA WERE COLLECTED.
SPECIFY SPECIES BY USING THE FOLLOWING CODES:

PINE=1, HARD-HARDWOOD=2, SOFT-HARDWOOD=3, OAK SP.=4, LIVE OAK=5,
SWEETGUM=6, PINE2=7, SAND PINE=8, PLANT PINE=9, CYPRESS=10.

A MAXIMUM OF 6 SPECIES CAN BE TALLIED PER AREA (9 PER TRACT).
ENTER CODES, FOR SPECIES TALLIED, ON ONE LINE SEPARATED BY COMMAS.
? 1,2,3 CR
1,2,3

ENTER DBH OF BORED TREES TO NEAREST TENTH OF AN INCH FOLLOWED BY THE
RADIAL GROWTH OF THE LAST 5 YEARS TO THE NEAREST HUNDREDTH OF AN INCH.
SEPARATE ENTRIES WITH COMMAS; YOU ARE ALLOWED UP TO 8 DBH/RADIAL GROWTH
PAIRS PER LINE.
YOU WILL BE PROMPTED BY SPECIES AND TREE SIZE CLASS. IF NO TREES
BORED, ENTER 'NONE'.

ENTER PINE MEASUREMENT DATA FOR AVERAGE PULPWOOD TREES
(5.0 TO 8.9 INCHES)
ENTER DBH,RADIAL GROWTH(5 YR.),.....

? 6.3,0.28,8.8,0.40,7.5,0.27,8.1,0.50,7.8,0.42 CR
6.3,0.28,8.8,0.40,7.5,0.27,8.1,0.50,8.0,0.42

ARE THE MEASUREMENTS YOU HAVE ENTERED CORRECT? (Y OR N)
? YES CR
YES

ENTER PINE MEASUREMENT DATA FOR AVERAGE SAWTIMBER TREES
(> 9.0 INCHES)
ENTER: DBH,RADIAL GROWTH(5 YR.),....

? 10.2,0.58,12.0,0.65,9.3,0.41,9.5,0.57,9.2,0.31 CR
10.2,0.58,12.0,0.65,9.3,0.41,9.5,0.57,9.2,0.31

ARE THE MEASUREMENTS YOU HAVE ENTERED ABOVE CORRECT? (Y OR N)
? YES CR
YES

(If no increment-core data to be entered, the question asking for radial
growth will not appear.)

IF THE DIMENSION MEASURED FOR A SIZE CLASS IS
DBH ONLY, ENTER THE DBH CLASS FOLLOWED BY ITS TREE COUNT.
IF DBH AND HEIGHT ARE MEASURED, ENTER THE DBH CLASS FOLLOWED
BY THE INITIAL HEIGHT CLASS MEASURED FOLLOWED BY THE
TREE COUNTS (REMAINING HEIGHTS NEED NOT BE ENTERED)
MAKE SURE TO INCLUDE ZERO COUNTS IF SURROUNDED BY NON-ZERO COUNTS.
SEPARATE EACH ELEMENT OF DATA BY A COMMA. ENTER ONLY ONE DBH CLASS TO
A LINE. YOU WILL BE PROMPTED BY SPECIES FOR INPUT.

PINE CRUISE DATA INPUT SECTION

ENTER PINE CRUISE DATA.
YOU WILL BE PROMPTED BY SIZE CLASS - IF THERE ARE NO DATA FOR A SIZE CLASS, ENTER 'NONE'. SIGNAL END OF DATA INPUT, FOR EACH SIZE CLASS, WITH AN 'END'.

* SAPLINGS (1-4 IN. DBH):
? 2,6 CR
2,6
? 4,18 CR
4,18
? END CR
END

* PULPWOOD (5- 8 IN. DBH):
? 6,10,4,11,12 CR
6,10,4,11,12
? 8,20,6,17,27,8 CR
8,20,6,17,27,8
? END CR
END

* PULPWOOD (IN TREES > 8 IN. DBH):
? 12,40,2,1 CR
12,40,2,1
? 16,50,2 CR
16,50,2
? END CR
END

* SAWTIMBER (> 8 IN. DBH):
? 10,1.0,5,20,20,1 CR
10,1.0,5,20,20,1
? 12,1.0,2,16,25,8 CR
12,1.0,2,16,25,8
? 14,1.5,16,12 CR
14,1.5,16,12
? 16,1.5,2,15,14 CR
16,1.5,2,15,14
? 18,1.5,1,2,3,1 CR
18,1.5,1,2,3,1
? 20,1.5,1,4,4,1 CR
20,1.5,1,4,4,1
? END CR
END

SUMMARY OF PINE TREE COUNT INPUT DATA

PINE - SAPLINGS

DBH	TREE COUNT
2	6
4	18

PINE - PULPWOOD

	HT. TO 4 IN. TOP(FT.)												
DBH	10	20	30	40	50	60	70	80	90	100	110	120	130	140
6	4	11	12											
8		6	17	27	8									

PINE - PULPWOOD

	HT. TO 4 IN. TOP(FT.)												
DBH	10	20	30	40	50	60	70	80	90	100	110	120	130	140
12				2	1									
16					2									

PINE - SAWTIMBER

	MERCHANTABLE HT.(LOGS)											
DBH	0.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
10		5	20	20	1							
12		2	16	25	8							
14			16	12								
16			2	15	14							
18			1	2	3	1						
20			1	4	4	1						

* THE ABOVE TABLE SUMMARIZES THE GIVEN PINE INPUT. IF YOU ARE SATISFIED, ENTER 'YES'. IF YOU WANT TO MAKE CORRECTIONS IN THE ABOVE TABLE, ENTER THE SIZE CLASSES YOU WISH TO CHANGE OR MAKE ADDITIONS TO (1=SAPLINGS, 2=PULPWOOD, 3=SAWTIMBER, 4=LARGE PULPWOOD). SEPARATE CODES WITH COMMAS.

? YES CR

YES

HARD-HWD CRUISE DATA INPUT SECTION

ENTER HARD-HWD CRUISE DATA.
YOU WILL BE PROMPTED BY SIZE CLASS - IF THERE ARE NO DATA FOR A SIZE CLASS, ENTER 'NONE'. SIGNAL END OF DATA INPUT, FOR EACH SIZE CLASS, WITH AN 'END'.

At this point in the program the user would enter the tree counts by d.b.h. and height classes by tree size class in the same manner as was done for the pine. The program would then print out the summary of the hard hardwood input for the user to check and make corrections. After telling the program the hard hardwood input data were correct, the program would ask for soft hardwood data input.

After the cruise data for each species tallied in an area have been entered, the program will ask the following question if more than one area in a tract has been cruised.

```
DO YOU WANT TO CONTINUE THE NEXT AREA (Y OR N)
?
```

Data entry for each area in a tract starts with question 3 (page 30). After answering question 3 for an area the following question will be asked:

```
THE STORED PRESELECTED CRUISE PARAMETERS USED FOR THE PREVIOUS AREA WILL
BE USED FOR THIS AREA UNLESS SPECIFIED OTHERWISE.  ENTER 'YES' TO REUSE
THESE STORED OPTIONS OR 'NO' IF CHANGES ARE DESIRED.
```

If the above question is answered "Yes," the program will immediately ask for cruise data entry. If the above question is answered "No," the program will ask question 4 (page 32).

After all cruise data for each area have been entered, the computer will calculate estimated weights and volumes and route output to the terminal or line printer.

Output and Examples

Output from this program is designed to provide the forester, landowner, or timber buyer with information to evaluate the utilization options for marketing the timber. The output from the program shows the aggregate weight and volume of the total tree above-stump for trees in the stand by species or species groups. It breaks down these estimates into saw logs, plylogs, pulpwood, crown firewood, and logging residue and gives these estimates in tons, cords, cunits and board feet per acre or by area and tract totals. This information is provided in four basic output tables: a table showing board-foot volume by d.b.h., a table showing total-tree and tree-component biomass by d.b.h. class, a summary table, and a table showing projected annual growth by stand component and species.

Exhibit 3 is an example of the output displayed in Tables 1A, 1B, and 1C which show predicted gross board-foot volumes based on the Doyle, Scribner, or International 1/4-inch board-foot rules, respectively. These output tables show the predicted board-foot volume by d.b.h. class, the totals for each species, and the total board feet over all species for the specified form class; also displayed are the average saw-log heights and numbers of trees by species and d.b.h. class.

Exhibit 4 is an example of the output displayed in Tables 2A, 2B, and 2C which show estimated total-tree and tree-component biomass expressed in tons, cords, and cunits, respectively. These output tables show predicted biomass for the total tree above-stump, stem from butt to the specified pulpwood top, saw-log stem, stem pulpwood, and hardwood crown firewood $\geq$ 4 inches d.o.b. Stem pulpwood consists of the stem from butt to the specified pulp d.o.b. top in pulpwood trees and the stem pulpwood above the sawtimber top in sawtimber trees. When planted pine cruise data are analyzed and chipping saw logs are requested, Table 2 will display the weight or volume of chipping logs instead of saw logs. Also shown in Table 2 is the average height and the estimated number of trees by d.b.h. classes.

EXHIBIT 3.--EXAMPLE OF TABLE 1B SHOWING ESTIMATED SCRIBNER BOARD-FOOT VOLUME FOR FORM CLASS 78 BY DBH CLASS.

TOTAL TREE MULTI-PRODUCT CRUISE PROGRAM

LANDOWNER -	JOHN DOE	CASE NO. -	16A
ADDRESS -	MAIN ST ATHENS GA 30602	DISTRICT NO. -	14
TRACT LOC. -	GLYNN CO	TOTAL TRACT(AC) -	40.0
AREA 1 -	PINE-HARDWOOD	AREA 1 ACREAGE -	40.00
FORESTER -	SMITH	PHONE -	912-546-2441
ADDRESS -	WAYCROSS GA	DATE -	84/12/09

TABLE 1B--PREDICTED SCRIBNER GROSS SAWLOG BD.FT. VOLUME BY DBH CLASSES.
CURRENT ESTIMATES - YIELD PER ACRE

DBH	AVERAGE HEIGHT			EST. NO. OF TREES			SAWLOG VOLUME-SCRIBNER,FC /1/			
(IN.)	-------(LOGS)-------			-------(NUMBER)-------			-----(THOUSAND BOARD FEET)-----			
	PINE	HHWD	SHWD	PINE	HHWD	SHWD	PINE	HHWD	SHWD	ALL SPECIES
10	1.7	.0	.0	21.1	.0	.0	.8	.0	.0	.8
12	1.9	1.5	2.0	16.2	1.6	2.5	1.2	.1	.2	1.4
14	1.7	1.8	2.4	6.5	3.7	5.1	.7	.4	.7	1.7
16	2.2	2.0	2.5	5.6	.7	.7	.9	.1	.1	1.2
18	2.3	2.0	.0	1.0	.3	.0	.2	.1	.0	.3
20	2.3	.0	.0	1.1	.0	.0	.3	.0	.0	.3
ALL CLASSES				51.6	6.3	8.4	4.1	.7	1.0	5.8

/1/ FORM CLASS: PINE= 78.; SOFT HWD= 78.; HARD HWD= 78.

EXHIBIT 4.--EXAMPLE OF TABLE 2A SHOWING ESTIMATED TOTAL-TREE AND TREE-COMPONENT BIOMASS IN TONS BY DBH CLASS.

TOTAL TREE MULTI-PRODUCT CRUISE PROGRAM

LANDOWNER -	JOHN DOE	CASE NO. -	16A
ADDRESS -	MAIN ST ATHENS GA 30602	DISTRICT NO. -	14
TRACT LOC. -	GLYNN CO	TOTAL TRACT(AC) -	40.0
AREA 1 -	PINE-HARDWOOD	AREA 1 ACREAGE -	40.00
FORESTER -	SMITH	PHONE -	912-546-2441
ADDRESS -	WAYCROSS GA	DATE -	84/12/09

TABLE 2A--PREDICTED TOTAL TREE AND COMPONENT BIOMASS BY DBH CLASSES.
CURRENT ESTIMATE - YIELD PER ACRE

DBH	AVERAGE HEIGHT	EST. TREES	TOTAL TREE	STEM TO PULP TOP /1/	SAWLOGS	STEM PULPWOOD	FIREWOOD >= 4 IN.
(IN)	(FT.&LOGS)	(NO.)	----------TONS----------				
			PINE				
			--SAPLINGS--				
2	.0	68.8	.6				
4	.0	51.6	2.9				
			--PULPWOOD--				
6	23.0	34.4	5.1	3.3		3.3	
8	36.4	41.5	13.0	10.6		10.6	
12	43.3	1.0	.7	.6		.6	
16	50.0	.4	.5	.4		.4	
			--SAWTIMBER--				
10	1.7	21.1	9.9	8.8	7.1	1.7	
12	1.9	16.2	12.7	10.4	8.4	1.9	
14	1.7	6.5	6.9	5.3	4.1	1.2	
16	2.2	5.6	8.5	6.7	5.6	1.1	
18	2.3	1.0	1.9	1.5	1.3	.2	
20	2.3	1.1	2.7	2.1	1.8	.4	
ALL CLASSES		249.1	65.4	49.9	28.3	21.6	

/1/ STEM PULPWOOD TOP:
PULPWOOD - 4-IN. FOR PINE; 4-IN. FOR HHWD; 4-IN. FOR SHWD.
SAWTIMBER - 4-IN. FOR PINE; 4-IN. FOR HHWD; 4-IN. FOR SHWD.

The summary consists of two tables, Table 3A and Table 3B. Table 3A (Exhibit 5) shows the predicted total biomass of all trees in the stand in tons, cords, and cunits for each species and all species combined. Estimated total biomass is displayed for saplings (1.0 to 4.0 inches), and for trees ≥ 5.0 inches d.b.h. The biomass in trees ≥ 5.0 inches is divided into material in the stem to the specified pulpwood top and material in the crown (branches and stem above the pulp d.o.b. top). The stem to a pulpwood top is further separated into saw-log and pulpwood components. The pulpwood component consists of estimates of pulpwood from pulpwood-size trees and of that which comes from the tops of sawtimber-size trees. When natural pine data are analyzed and the user selects the plylog option, the saw-log stem is separated into plylogs and small saw logs and their weights and volumes displayed. The amount of crown that is ≥ 4 inches d.o.b. is also displayed for hardwoods as crown firewood. When planted pine cruise data are analyzed and the chipping-log option selected, chipping-log estimates are displayed instead of saw-log estimates in Table 3A.

Table 3B (Exhibit 6) displays the total board-foot volume for each species by the desired log rules for all saw logs, small saw logs, and plylogs. This table also shows the estimated average basal areas per acre in square feet and average quadratic mean d.b.h. for saplings, pulpwood, and sawtimber-size trees for each species.

Output Table 4 (Exhibit 7) shows the projected annual growth by stand component for each species tallied. Annual growth estimates are based on 5-year increment-core measurements of radial growth entered by the user, or stored average annual radial growth values. The present volume per acre, present growth per acre per year, and total annual growth for the stand-by-stand component are displayed. Annual growth is expressed in board feet for saw logs, in cords for pulpwood, and in tons for total-tree chips. When planted pine chipping-log estimates are desired, chipping-log annual growth is expressed in cords. The stem to pulp top growth values in Exhibit 5 are for the total stem from butt to the pulp top and the pulpwood values are for pulpwood from pulpwood-size tree and tops of sawtimber-size trees. Percent annual change per acre is also shown for each stand component.

Using the stand table projection method, the current tree tallies can be projected for up to 5 years and Tables 3A and 3B can be reprinted to show estimates of future weights and volumes. Output Tables 1 to 3 can be printed on a per acre or area basis. Tables 3A and 3B, the summary tables showing current or projected weight and volume, can be printed to summarize all areas within a tract. Table 4, the table showing annual growth, can also be printed to summarize growth by stand component for a tract.

Interpretation of Output

The TTMP Cruise Program is designed to predict gross total-tree and tree-component stand weights and volumes by using regional species equations. Thus, these estimates should be interpreted and used carefully. Estimates are made assuming efficient utilization will be followed during timber harvesting. If the loggers fail to cut saw logs to the upper stem limit cruised, or cut stem pulpwood to only a 6-inch rather than a 4-inch small end diameter, the program will overestimate product yields. Therefore, users should change pulpwood top diameters used in the program to coincide with local harvesting practices.

The output tables showing biomass by d.b.h. classes (Tables 2A, 2B, 2C) and the summary (Table 3A), contain weight and volume estimates for the basic components of the tree. These basic values permit users to combine component estimates to simulate harvesting practices in their area. For example, in some areas only hardwood saw logs can be sold commercially and no market for hardwood pulpwood exists. Stem pulpwood estimates therefore would be combined with crown firewood and marketed as firewood.

EXHIBIT 5.--EXAMPLE OF TABLE 3A WHICH SUMMARIZES THE PREDICTED TOTAL-TREE AND TREE-COMPONENT WEIGHTS AND VOLUMES BY SPECIES.

TOTAL TREE MULTI-PRODUCT CRUISE PROGRAM

LANDOWNER -	JOHN DOE	CASE NO. -	16A
ADDRESS -	MAIN ST ATHENS GA 30602	DISTRICT NO. -	14
TRACT LOC. -	GLYNN CO	TOTAL TRACT(AC) -	40.0
AREA 1 -	PINE-HARDWOOD	AREA 1 ACREAGE -	40.00
FORESTER -	SMITH	PHONE -	912-546-2441
ADDRESS -	WAYCROSS GA	DATE -	84/12/09

TABLE 3A--SUMMARY OF PREDICTED TOTAL TREE AND COMPONENT WEIGHT AND VOLUME.
CURRENT ESTIMATE - YIELD PER ACRE

COMPONENT	PINE	HARD-HWD	SOFT-HWD	ALL TREES
	GREEN TONS OF WOOD AND BARK			
TOTAL TREE(ALL)	65.4	19.5	18.4	103.3
SAPLINGS(< 5 IN.)	3.5	3.5	3.1	10.1
TOTAL TREE(> 5 IN.)	61.9	16.0	15.2	93.2
STEM TO PULPWOOD TOP /1/	49.9	11.5	12.2	73.6
ALL SAWLOGS /2/	28.3	5.0	7.0	40.3
SMALL SAWLOGS /5/	19.8	.0	.0	19.8
PLYLOGS /6/	8.5	.0	.0	8.5
PULPWOOD (ALL)	21.6	6.5	5.1	33.2
PULPWOOD TREES	15.0	4.5	3.2	22.7
SAWTIMBER TOPS	6.6	2.0	2.0	10.5
TOTAL CROWN	12.1	4.5	3.1	19.6
CROWN FIREWOOD>= 4IN	.0	.9	.7	1.6
	CORDS OF WOOD AND BARK /4/			
TOTAL TREE(ALL)	23.4	6.9	6.4	36.7
SAPLINGS(< 5 IN.)	1.2	1.2	1.1	3.6
TOTAL TREE(> 5 IN.)	22.1	5.6	5.4	33.1
STEM TO PULPWOOD TOP /1/	17.8	4.1	4.3	26.1
ALL SAWLOGS /2/	10.1	1.8	2.5	14.3
SMALL SAWLOGS /5/	7.1	.0	.0	7.1
PLYLOGS /6/	3.0	.0	.0	3.0
PULPWOOD (ALL)	7.7	2.3	1.8	11.8
PULPWOOD TREES	5.4	1.6	1.1	8.1
SAWTIMBER TOPS	2.3	.7	.7	3.7
TOTAL CROWN	4.3	1.6	1.1	7.0
CROWN FIREWOOD>= 4IN	.0	.3	.2	.6
	VOLUME OF WOOD (CUNITS)			
TOTAL TREE(ALL)	17.6	5.0	5.3	27.8
SAPLINGS(< 5 IN.)	.9	.9	.9	2.7
TOTAL TREE(> 5 IN.)	16.7	4.1	4.3	25.1
STEM TO PULPWOOD TOP /1/	13.5	3.0	3.5	20.0
ALL SAWLOGS /2/	7.8	1.3	2.1	11.2
SMALL SAWLOGS /5/	5.5	.0	.0	5.5
PLYLOGS /6/	2.3	.0	.0	2.3
PULPWOOD (ALL)	5.7	1.7	1.5	8.8
PULPWOOD TREES	4.1	1.2	1.0	6.2
SAWTIMBER TOPS	1.6	.5	.5	2.6
TOTAL CROWN	3.2	1.1	.8	5.1
CROWN FIREWOOD>= 4IN	.0	.2	.2	.4

/1/ STEM PULPWOOD TOP:
PULPWOOD - 4-IN. FOR PINE; 4-IN. FOR HHWD; 4-IN. FOR SHWD.
SAWTIMBER - 4-IN. FOR PINE; 4-IN. FOR HHWD; 4-IN. FOR SHWD.
/2/ SAWLOG MERCHANTABILITY: 7-IN. FOR PINE W/MIN DBH 9-IN., 9-IN. FOR HARDWOOD OR THRU LOG GRADE NO. 3 MERCHANTABILITY W.MIN DBH 11-MIN.
/3/ NUMBER MAY NOT ADD DUE TO ROUNDING ERROR.
/4/ POUNDS PER CORD: PINE=5600. HHWD=5700. SHWD=5700.
/5/ SMALL SAWLOGS - MIN 8 F. W/ MIN 7-IN. DOB SMALL END.
/6/ PLYLOGS - MIN 2 8.7 FT. BLOCK W/ MIN 10.0-IN. DOB SMALL END, MIN DBH - 14.0.

EXHIBIT 6.--EXAMPLE OF TABLE 3B WHICH SUMMARIZES THE PREDICTED SAW-LOG BOARD-FOOT VOLUMES AND BASAL AREA PER ACRE BY SPECIES.

TOTAL TREE MULTI-PRODUCT CRUISE PROGRAM

LANDOWNER -	JOHN DOE	CASE NO. -	16A
ADDRESS -	MAIN ST ATHENS GA 30602	DISTRICT NO. -	14
TRACT LOC. -	GLYNN CO	TOTAL TRACT(AC) -	40.0
AREA 1 -	PINE-HARDWOOD	AREA 1 ACREAGE -	40.00
FORESTER -	SMITH	PHONE -	912-546-2441
ADDRESS -	WAYCROSS GA	DATE -	84/12/09

TABLE 3B--SUMMARY OF PREDICTED TOTAL TREE AND TREE COMPONENT WEIGHT AND VOLUME.
CURRENT ESTIMATE - YIELD PER ACRE

COMPONENT	PINE	HARD-HWD	SOFT-HWD	ALL TREES
	SAWLOG BOARD-FOOT VOLUME---(MBF)/1/			
ALL SAWLOGS				
DOYLE	2.6	.4	.6	3.7
SCRIBNER	4.1	.7	1.0	5.8
SMALL SAWLOGS				
DOYLE	1.6	.0	.0	1.6
SCRIBNER	2.6	.0	.0	2.6
PLYLOGS				
DOYLE	1.1	.0	.0	1.1
SCRIBNER	1.5	.0	.0	1.5
	BASAL AREA PER ACRE (SQ.FT.)			
SAPLING TREES	5	4	5	14
PULPWOOD TREES	22	6	5	33
SAWTIMBER TREES	43	6	8	57
ALL TREES	70	16	18	104
	QUADRATIC MEAN D.B.H. (IN.)			
SAPLING TREES	3.0	3.2	2.6	2.9
PULPWOOD TREES	7.3	7.4	7.1	7.3
SAWTIMBER TREES	12.4	14.0	13.6	12.7
ALL TREES	7.3	5.6	4.6	6.2

/1/FORM CLASS: PINE= 78.; SOFT HWD= 78. HARD HWD= 78.

EXHIBIT 7.--EXAMPLE OF TABLE 4 WHICH SHOWS PROJECTED ANNUAL GROWTH OVER 5 YEARS BY STAND COMPONENT.

TOTAL TREE MULTI-PRODUCT CRUISE PROGRAM

LANDOWNER - JOHN DOE
ADDRESS - MAIN ST ATHENS GA 30602
TRACT LOC.- GLUNN CO
AREA 1 - PINE-HARDWOOD
FORESTER - SMITH
ADDRESS - WAYCROSS GA

CASE NO. - 16A
DISTRICT NO. - 14
TOTAL TRACT(AC) - 40.0
AREA 1 ACREAGE - 40.00
PHONE - 912-546-2441
DATE - 84/12/09.

TABLE 4.--BASIC INVENTORY AND PROJECTED ANNUAL GROWTH

STAND COMPONENT	PRESENT VOLUME PER ACRE	PRESENT GROWTH PER ACRE PER YEAR	TOTAL ANNUAL GROWTH PER AREA	PERCENT ANNUAL CHANGE PER ACRE
AREA 1-- 40.00 ACRES-PINE-HARDWOOD				
PINE				
ALL SAWLOGS (MBF SCRIB)	4.1	.233	9.34	5.67
SMALL SAWLOGS (MBF)/1/	2.6	.188	4.70	4.49
PLYLOGS (MBF)/2/	1.5	.116	4.64	7.73
STEM TO PULP TOP (CORDS)	17.8	.630	25.18	3.54
PULPWOOD (CORDS)	7.7	.124	4.95	1.61
TOTAL TREE CHIPS (TONS)	65.4	2.074	82.98	3.17
HARD-HWD				
ALL SAWLOGS (MBF DOYLE)	0.4	.018	0.71	3.98
STEM TO PULP TOP (CORDS)	4.1	.152	6.07	3.75
PULPWOOD (CORDS)	2.3	.111	4.42	4.83
TOTAL TREE CHIPS (TONS)	19.5	.545	21.81	2.79
SOFT-HWD				
ALL SAWLOGS (MBF DOYLE)	0.6	.019	0.75	2.99
STEM TO PULP TOP (CORDS)	4.3	.102	4.06	2.38
PULPWOOD (CORDS)	1.8	.056	2.25	3.12
TOTAL TREE CHIPS (TONS)	18.4	.339	13.57	1.85
ALL SPECIES				
ALL SAWLOGS (MBF)				
SAWLOGS (DOYLE)	1.1	.036	1.46	3.40
SAWLOGS (SCRIB)	4.1	.233	9.34	5.67
STEM TO PULP TOP (CORDS)	26.1	.883	35.32	3.38
PULPWOOD (CORDS)	11.8	.290	11.62	2.46
TOTAL TREE CHIPS (TONS)	103.3	2.959	118.35	2.86

/1/SMALL SAWLOGS - MIN 8 FT. W/ MIN 7-IN. DOB SMALL END.
/2/PLYLOGS - MIN 2 8.7 FT. BLOCK W/ MIN 10.0-IN. DOB SMALL END, MIN DBH - 14.0.

NOTE: NEGATIVE REFLECTS MOVEMENT OF MATERIAL INTO LARGER SIZE COMPONENT OR MORTALITY GREATER THAN GROWTH.
GROWTH ASSUMES APPROX. 1% ANNUAL MORTALITY.

The TTMP Cruise Program assumes that the cruise analyzed was a random sample and will therefore lead to unbiased estimates. These biomass estimates, however, contain errors due not only to harvesting differences but also to biomass prediction equations and timber cruise procedures. When timber is 100 percent cruised, the error associated with the cruise is minimized since all trees are tallied. Preliminary tests of the program that used this cruise procedure indicate that predicted total tree, total stem to pulpwood top, and saw-log weights and volumes will be within + 10 percent of the actual weights and volumes if d.b.h. and some estimate of $\overline{h}$eight are tallied. Biomass of upper stem pulpwood and crown firewood varies considerably more. Users should use these component estimates carefully until they gain field experience as to their reliability. Biomass estimates based on fixed-area plots, point sampling, or strip cruising can contain more error than those based on a 100 percent cruise. To minimize sampling error, plots and strips must be located without bias, border trees must be measured carefully to determine if they are in or out of the cruise, and a sufficient number of plots and strips must be taken.

The growth projections calculated by this program are designed to provide growth information for short-term management planning and when stands are cruised but not harvested for 1 to 5 years. When stand projections are made with the radial growth values stored in the program and which are based on the regional average for the species group, users should apply these values carefully. The stand cruised could be growing at a rate different from the average for their physiographic region. When accurate growth projections are required, the user should enter increment-core growth values for the pulpwood and sawtimber trees cruised. The trees to be bored must be selected randomly to avoid bias in growth estimates.

An average mortality rate (page 10) is assumed in the program when projected growth is calculated. These mortality rates, however, may not be applicable to the stands cruised. Thus, the user should adjust the reported projected growth to account for local mortality rates.

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APPENDIX

Appendix A--Computational Procedures

Regression equations are stored in the program for estimating the green weight of wood and bark (excluding foliage) and volume of wood in the total-tree above-stump and its components that use d.b.h. (D) or d.b.h. in combination with total height (Th), height to a 4-inch d.o.b. top (H4), or saw-log merchantable height (Mh). Shown below are the tree components estimated by using these independent variables by tree size class.

Tree size class	Independent variable	Component estimated
Saplings	D^2, D^2+Th	Total-tree above-stump
Pulpwood and large pulpwood	D^2, D^2+Th, D^2+H4	Total-tree above-stump, stem from butt to tip
Large pulpwood hardwoods only	D^2, D^2+Th, D^2+H4	All material in total tree $\geq$ 4-in. d.o.b.
Sawtimber	D2, D2+Th, D2+H4, D2+Mh	Total-tree above-stump, saw-log stem, All materials in total tree > 4-in. d.o.b. (Hardwoods only)

Component Weights and Volumes

The following allometric regression equations are used to estimate component weights and volumes:

$$Y = a(X)^b \quad (1)$$

or

$$Y = a(X_1)^b (X_2)^c \quad (2)$$

where:

Y = component weight or volume

$X = D^2$ or $D^2 * Th$ or $D^2 * H4$

$X_1 = D^2$

X_2 = Th or H4 or Mh

When trees are tallied by d.b.h., or by d.b.h. and total height or height to 4-in. d.o.b. top, weight and volume of stem to sawtimber and pulpwood tops are estimated by using the following ratio equation (Clark and Thomas 1984) to estimate the proportion of the predicted total-stem weight or volume to the specified top d.o.b.:

$$Y_R = e^{a(d^b D^c)} \quad (3)$$

where:

Y_R = stem to top d.o.b./total-stem ratio

d = specified top diameter in inches

D = tree diameter at breast height in inches

a,b,c = regression coefficients

e = base of natural logs

Since equation (3) is used to estimate the proportion of the stem to any top d.o.b., the user has the option of specifying the pulpwood d.o.b. top to be used in analyzing the cruise data. A different top d.o.b. can be specified for pine, hard hardwoods, and soft hardwoods.

When sawtimber trees are tallied by d.b.h., or by d.b.h. and total height or height to a 4-inch top, a fixed sawtimber top d.o.b. of 7 inches is used for pine and 9 inches for hardwoods. Tallying hardwoods by total height or height to a 4-inch top can result in an overestimate of the saw-log portion of the stem. This occurs because hardwoods generally do not have enough stem quality to produce grade 3 logs to a 9-inch top in large diameter trees.

When trees are tallied by d.b.h. and saw-log merchantable height, the following ratio model (Clark and Thomas 1984) is used to expand estimated saw-log weight or volume to pulpwood stem weight or volume to any d.o.b. top above the saw-log top.

$$Y_R = e^{a\ [(Mh)^b\ ((1-(\frac{d}{.78D})^2)^2)^c]} \quad (4)$$

where:

Y_R = stem to top d.o.b./saw-log stem ratio

Mh = saw-log merchantable height in feet

d = specified top diameter in inches

D = tree diameter at breast height in inches

a,b,c = regression coefficients

e = base of natural logs

Equation (4) allows the user to specify the pulpwood top diameter desired for sawtimber trees tallied by d.b.h. and saw-log merchantable height in logs. Stem pulpwood above the saw-log top in sawtimber-size trees is estimated by subtracting estimated stem weight or volume to saw-log top from stem weight or volume to the pulpwood top.

Crown (branches plus stem above pulp top) weights and volumes are estimated by subtracting predicted stem weight or volume to the pulp d.o.b. top from predicted total-tree weight or volume. Weight and volume of hardwood crown firewood $\geq$ 4 inches is predicted by subtracting stem weight or volume to the pulp top from the predicted weight or volume of all material in the tree $\geq$ 4 inches d.o.b.

The user has the option of separating the saw-log merchantable stem of pines into plylogs and small saw logs. When sawtimber pines are tallied by d.b.h. and saw-log merchantable heights, the heights to the minimum plylog d.o.b. top are estimated by using the following equation based on those developed by Bennett and Swindel (1972):

$$Ph = [(H-4.5)(\frac{D-Pd}{D})]a + [((H-4.5)(\frac{D-Pd}{D}))^2]b \qquad (5)$$

where:

Ph = height to plylog minimum d.o.b.

D = tree diameter at breast height in inches

Pd = minimum plylog d.o.b. in inches

H = saw-log stem merchantable height, total height or height to 4-inch top

a,b = regression coefficients (different coefficients are used for each height)

The minimum plylog d.o.b. top (Pd) can be specified by the user or the default value (10 inches) used. The user can also specify the minimum d.b.h. tree from which plylogs can be harvested. The plylog height estimated with equation (5) is rounded back to 8.7-foot segments plus 0.5 foot for stump height. A tree must contain a minimum of two 8.7-foot peeler blocks to make a plylog tree.

The rounded plylog height (Ph) is then substituted for saw-log merchantable heights in the D^2+Mh equations and the weight and volume of the plylog stem estimated. Weights and volumes of small saw logs are estimated by subtracting the estimated weight or volume of plylog stem from the weight or volume of the saw-log stem.

When pine trees are tallied by d.b.h. and total height (Th) or d.b.h. and height to 4-inch top (H4), Th or H4 are substituted in equation (5) and appropriate coefficients used to estimate the height to the specified plylog d.o.b. The estimated plylog height is then rounded back to 8.7-foot intervals plus 0.5 foot for a stump and the following taper curve equation used to estimate the final plylog d.o.b. (Pd) at this point on the stem (Bennett and Swindel 1972).

$$Pd = a\left[\frac{D(H-Pht)}{(H-4.5)}\right] + b[(H-Pht)(Pht-4.5)] + c[H(H-Pht)(Pht-4.5)] + d[(H-Pht)(Pht-4.5)(H+Pht-4.5)] \quad (6)$$

where:

Pd = d.o.b. at the rounded plylog height in inches

D = tree diameter at breast height in inches

H = tree total height or height to 4-inch d.o.b. top in feet

Pht = rounded plylog height from equation (5) in feet

a,b,c = regression coefficients

The proportion of total-stem weight or volume to the estimated plylog d.o.b. (Pd) is estimated by substituting (Pd) for d in equation (3). The weight or volume of small saw logs is estimated by subtraction. When sawtimber trees are tallied by d.b.h. only, no plylog or small saw-log estimate is made.

When analyzing plantation pine cruise data, the user has the option of separating the stem to the pulpwood top into chipping logs and upper stem pulpwood. The user can specify a minimum d.o.b. top to which chipping logs can be cut and the minimum d.b.h. tree from which chipping logs can be processed. The proportion of total-stem weight or volume to a user-specified minimum chipping-log top d.o.b. is estimated by using equation (3). The upper stem pulpwood weight or volume is estimated by subtracting the weight or volume of chipping-log stem from the weight or volume of the stem to the pulpwood d.o.b. top.

Board-Foot Volume Equations

Equations for estimating the Doyle, Scribner, and International 1/4-inch saw-log stem board-foot volumes were developed from Mesavage and Girard's volume tables form class 78 (Mesavage and Girard 1956). These equations are listed below:

Doyle Board Foot (trees 9 to 24 inches d.b.h.)

$$Y = 0.00153(D^2)^{1.60122}(L^3)^{0.21566} \quad (7)$$

$$R^2 = 0.99 \quad S_{y.x}\log_{10} = 0.0315$$

Doyle Board Foot (trees greater than 24 inches d.b.h.)

$$Y = 0.00244(D^2)^{1.48489}(L^3)^{0.23199} \quad (8)$$

$$R^2 = 0.99 \quad S_{y.x}\log_{10} = 0.0358$$

Scribner Board Foot

$$Y = -16.40224 + 0.06777(D^2) + 0.02376(D^2L) - 0.00265(DL^2) + 0.000097(L^3) \quad (9)$$

$$R^2 = 0.99 \quad S_{y.x} = 2.8 \text{ bd. ft.}$$

International 1/4-inch

$$Y = -2.788196 + 0.04587(D^2) + 0.02560(D^2L) - 0.00291(DL^2) + 0.00015(L^3) \quad (10)$$

$$R^2 = 0.99 \quad S_{y.x} = 3.0 \text{ bd. ft.}$$

where:

Y = stem volume to saw-log merchantable top in board feet

D = tree d.b.h. in inches

L = tree saw-log merchantable height with 0.5-foot stump allowance in feet (1 log = 16.3 feet)

The predicted volumes from equations (7), (8), (9), and (10) and predicted volumes from board-foot equations by Wiant and Castaneda (1977) were compared with the Mesavage and Girard tables. The sums of the residuals squared showed that the Scribner and International 1/4-inch equations listed above performed better than Wiant and Castaneda's but that their Doyle equation listed below was a better predictor than equations (7) and (8).

Wiant and Castaneda's Doyle Board-Foot Equation

$$Y = (0.55743 * (Log)^2 + 41.51275 * (Log) - 29.37337) +$$

$$((2.78043 - 0.04516 * (Log)^2 - 8.77272 * (Log)) * (D)) +$$

$$((0.04177 - 0.01578 * (Log)^2 + 0.59042 * (Log)) * (D)^2) \quad (11)$$

$$R^2 = 0.99$$

where:

Log = number of 16-foot saw logs

D = tree d.b.h. in inches

Thus, equations (9), (10), and (11) are used in the program to estimate saw-log stem board-foot volume of sawtimber-size trees. The user can specify the log rule and form class to be used for estimating pine, hard hardwood, and soft hardwood board-foot volumes. For each unit change in form class, the predicted board-foot volumes are adjusted up or down by 3 percent (Mesavage and Girard 1956).

When sawtimber-size trees are tallied by total height or height to 4-inch d.o.b. top, the height to a saw-log top (7 inches d.o.b. for pine, 9 inches d.o.b. for hardwoods) is estimated with the following equations:

Independent variable (Emh)	Regression equation	Coefficient of determination (R^2)	Standard error (Sy.x)
			(Feet)
PINE			
Height to 7-in. d.o.b. top	$Y = -346.429 + 104.919\sqrt{\log_{10}D^2} + 127.315(\log_{10}Th)$	0.87	4.2
	$Y = -280.191 + 83.871\sqrt{\log_{10}D^2} + 114.16711(\log_{10}H4)$	0.91	3.5
HARD HARDWOODS			
Height to 9-in. d.o.b. top	$Y = -346.975 + 122.4777\sqrt{\log_{10}D^2} + 106.170(\log_{10}Th)$	0.81	5.3
	$Y = -282.233 + 109.559\sqrt{\log_{10}D^2} + 88.303(\log_{10}H4)$	0.82	5.2
SOFT HARDWOODS			
Height to 9-in. d.o.b. top	$Y = -410.120 + 170.044\sqrt{\log_{10}D^2} + 101.663(\log_{10}Th)$	0.81	6.4
	$Y = -366.421 + 148.392\sqrt{\log_{10}D^2} + 101.792(\log_{10}H4)$	0.84	5.9

where:

Emh = estimated saw-log stem height to 7-inch d.o.b. for pine, 9-inch d.o.b. for hardwoods in feet

D = tree diameter at breast height in inches

Th = tree total height

H4 = height to 4-inch d.o.b. top in feet

a,b,c = regression coefficients

The estimated saw-log heights (Emh) and recorded d.b.h. are then used to estimate saw-log board-foot volume by using the appropriate log rule equations (9), (10), or (11).

Appendix B--Preselected Program Options

Preselected options are stored in the mainframe program for the commonly used tree dimensions, d.b.h. and height intervals, pulpwood top diameters, output tables by stand type, and cruise objective. The user can select to use the stored options (question 4, page 32) or answer option questions 6 to 14 as desired.

The type of stand--natural pine, plantation pine, hardwood or pine-hardwood--determines the tree dimensions used for measuring the trees in a cruise. The table below summarizes the tree dimensions measured and stem pulpwood d.o.b. top stored by stand type and tree size class. The stored dimensions measured are the same for natural pine, and hardwood or pine-hardwood stands.

Tree size class	Dimensions measured	Stem pulpwood top d.o.b.
		(Inches)
	NATURAL PINE AND HARDWOOD OR PINE-HARDWOOD	
Sapling	d.b.h.	
Pulpwood and large pulpwood	d.b.h. and height to 4-in d.o.b. top	4
Sawtimber	d.b.h. and saw-log height in logs	4
	PLANTATION PINE	
Sapling	d.b.h.	
Pulpwood and large pulpwood	d.b.h. and total height	4
Sawtimber	d.b.h. and total height	4

The preselected d.b.h. and height-class intervals used to record tally trees are determined by the cruise objective--timber sale, management plan, detailed cruise. Shown below are the d.b.h. and height-class intervals stored by cruise objective, stand type, and tree size class.

Stand type	D.b.h. interval (All tree classes)	Height interval (Saplings)	(Pulpwood)	(Sawtimber)
	(Inches)	-----(Feet)-----		(Feet or logs)
TIMBER SALE OR MANAGEMENT PLAN				
Natural pine	2	None	10	1/2
Planted pine	1	None	5	5
Pine-hardwoods	2	None	10	1/2
DETAILED CRUISE				
Natural pine	1	None	5	1/2
Planted pine	1	None	5	5
Pine-hardwoods	1	None	5	1/2

The purpose of the cruise determines the output tables printed. All preselected tables are area tables except Tables 1 and 2 under the management plan objective, which are per acre tables. Shown below are the output tables printed and their units of measure by cruise objective and stand type.

Output tables and units of measure	Output tables printed (Y=yes,blank=no)								
	Timber sale			Management plan			Detailed cruise		
	Natural pine	Planted pine	Pine hwd	Natural pine	Planted pine	Pine hwd	Natural pine	Planted pine	Pine hwd
TABLE 1									
A. Doyle			Y			Y			Y
B. Scribner	Y		Y	Y		Y	Y		Y
C. International									
TABLE 2									
A. Tons							Y	Y	Y
B. Cords		Y		Y	Y	Y	Y	Y	Y
C. Cunits							Y	Y	Y
TABLES 3A & 3B									
Current	Y	Y	Y	Y	Y	Y	Y	Y	Y
Projected				Y	Y	Y			
TABLE 4				Y	Y	Y			

TOTAL TREE MULTI-PRODUCT CRUISE PROGRAM--Summary Form for Recording Cruise Counts

District No. _____ Case No. _____ Landowner _____ Address _____
Geographic Region _____ Acreage in Tract _____ No. Areas in Tract _____ Tract Location _____
Forester _____ Address _____ Phone _____
Area No. _____ Area Acreage _____ Type Cruise _____ No. Plots _____ Planted or Natural _____
Area Identification _____ Species _____ Date _____

PLOT NO.	DBH	COUNT			DBH	COUNT				DBH	COUNT			DBH	COUNT		
	2				4					2				4			
1		PULPWOOD--HEIGHT TO 4-INCH TOP (FEET)															
2		10	20	30	40	50	60	70	80	10	20	30	40	50	60	70	80
3																	
4																	
5	6																
6																	
7	8																
8																	
9	10																
10																	
11																	
12																	
13																	
14		SAWTIMBER--SAW-LOG MERCHANTABLE HEIGHT (LOGS)															
15		1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5
16																	
17																	
18	12																
19																	
20	14																
	16																
	18																
	20																
	22																

TOTAL TREE MULTI-PRODUCT CRUISE PROGRAM--Summary Form for Recording Cruise Counts

District No. _____ Case No. _____ Landowner _____ Address _____
Geographic Region _____ Acreage in Tract _____ No. Areas in Tract _____ Tract Location _____
Forester _____ Address _____ Phone _____
Area No. _____ Area Acreage _____ Type Cruise _____ No. Plots _____ Planted or Natural _____
Area Identification _____ Species _____ Date _____

PLOT NO.	DBH	SAPLING COUNT				DBH	SAPLING COUNT			
1	2					4				
2		PULPWOOD--HEIGHT TO 4-INCH TOP (FEET)								
3		10	20	30	40	50	60	70	80	90
4										
5	6									
6										
7	8									
8										
9										
10										
11										
12										
13										
14										
15		SAWTIMBER--SAW-LOG MERCHANTABLE HEIGHT (LOGS)								
16		1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0
17										
18	10									
19										
20	12									
	14									
	16									
	18									
	20									

TOTAL TREE MULTI-PRODUCT CRUISE PROGRAM--Summary Form for Recording Cruise Counts

District No. _____ Case No. _____ Landowner _____ Address _____
Geographic Region _____ Acreage in Tract _____ No. Areas in Tract _____ Tract Location _____
Forester _____ Address _____ Phone _____
Area No. _____ Area Acreage _____ Type Cruise _____ No. Plots _____ Planted or Natural _____
Area Identification _____ Species _____ Date _____

Plot No.																
1																
2																
3																
4																
5																
6																
7																
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9																
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TOTAL TREE MULTI-PRODUCT CRUISE PROGRAM--Summary Form for Recording Cruise Counts

District No. _____ Case No. _____ Landowner _____ Address _____
Geographic Region _____ Acreage in Tract _____ No. Areas in Tract _____ Tract Location _____
Forester _____ Address _____ Phone _____
Area No. _____ Area Acreage _____ Type Cruise _____ No. Plots _____ Planted or Natural _____
Area Identification _____ Species _____ Date _____

Plot No.	Species	Sapling	2	4	Species	Sapling	2	4
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								
	Species				Species			

Clark, Alexander, III; Burgan, Thomas M.; Field, Richard C.; Dress, Peter E.
User's manual for Total-Tree Multiproduct Cruise Program. Gen. Tech. Rep. SE-31. Asheville, NC: U.S. Department of Agriculture, Forest Service, Southeastern Forest Experiment Station; 1985. 65 pp.

This interactive computer program uses standard tree-cruise data to estimate the weight and volume of the total tree, saw logs, plylogs, chipping logs, pulpwood, crown firewood, and logging residue in timber stands. Input is cumulative cruise data for tree counts by d.b.h. and height. Output is in tables: board-foot volume by d.b.h.; total-tree and tree-component biomass by tons, cords, and cunits; a summary table; and projected annual growth by stand component and species. This manual describes the FORTRAN V mainframe and the PASCAL microcomputer programs and how to enter data to obtain the desired output.

KEYWORDS: Computer program, inventory, biomass, tree weight, tree volume.

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The Forest Service, U.S. Department of Agriculture, is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives —as directed by Congress—to provide increasingly greater service to a growing Nation.